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ABSTRACT

Work Unit REALISTIC was undertaken by the Human Resources Research Organization to provide information concerning demands for reading, listening, and arithmetic skills in selected military occupational specialties and to provide information relevant to the matching of personnel literacy skills to job demands for such skils. This report describes results of research on (1) the relationship between the literacy skills of men in the military occupational specialties and their job proficiency, (2) the reading difficulty level of job printed materials and the extent of usage of these materials by men of different reading ability levels, (3) the extent to which men of differing reading ability levels ask questions of and listen for job information, and (4) the extent and nature of use of arithmetic by men of differing reading ability levels. Methods are discussed to reduce gaps between personnel literacy skill levels and the literacy demands of the jobs through job-oriented remedial literacy training or by redesigning the job literacy materials. Since reading ability was found to be most highly related to job proficiency, it is suggested that diagnostic, skill-oriented instruments be used for screening purposes. Tables, figures, references, and appendixes are included. (AW)

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Determination of Literacy Skill Requirements in Four Military Occupational Specialties

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16. Abstracts
This report describes results of research on the extent of usage of job printed materials and job listening sources as a function of the reading difficulty level of the materials and the reading ability of Army job incumbents. Psychometric data were obtained on relationships of reading ability to performance on Job-Related Reading Task tests, and of reading, listening, arithmetic, and AFQT to job proficiency as indexed by Job Knowledge tests, Job Sample tests, and Supervisor Ratings in four Army jobs. Methods are discussed for reducing discrepancies between personnel literacy skill levels and the literacy demands of the job by remedial literacy training or redesign of job literacy materials. Research results are discussed with regard to implications for selection, training, and research.

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The Human Resources Research Organization (HumRRO) is a nonprofit corporation established in 1969 to conduct research in the field of training and education. It is a continuation of The George Washington University Human Resources Research Office. HumRRO's general purpose is to improve human performance, particularly in organizational settings, through behavioral and social science research, development, and consultation. HumRRO's mission in work performed under contract with the Department of the Army is to conduct research in the fields of training, motivation, and leadership.

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

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FOREWORD

Work Unit REALISTIC was undertaken by the Human Resources Research Organization to provide information concerning demands for reading, listening, and arithmetic skills in selected military occupational specialties, and to provide information relevant to the matching of personnel literacy skills to job demands for such skills. This report presents information bearing on both of these objectives, with emphasis on the first. Information bearing on the second objective is discussed in separate reports of research on Sub-Unit REALISTIC III.

The research was conducted at HumRRO Division No. 3, Presidio of Monterey, California, where Dr. Howard H. McFann is Director.

Military support was provided by the U.S. Army Training Center Human Research Unit, Presidio of Monterey, California. Successive Military Chiefs of the Unit during the research project were LTC David S. Marshall, LTC Robert Emswiler, and LTC Ullrich Hermann.

The research was performed by Dr. Thomas G. Sticht, Dr. John S. Caylor, and Dr. Richard P. Kern, with the assistance of Mr. Lynn Fox, Mr. William H. Burckhartt, and Mrs. Rachel Chisum. Additional assistance was rendered by Dr. Richard McCrady who was with the Work Unit for several months and Mr. Donald F. Polden. Military assistants from the Human Research Unit were SP5 James Ford, SP4 Donald Enderby, SP5 Richard Ferrington, and SP5 Richard Wuerthner.

Research reported herein as Sub-Unit REALISTIC I made use of data collected by HumRRO Division No. 3 Work Unit UTILITY. The design and conduct of Work Unit UTILITY were executed by Dr. Robert Vineberg and Dr. Elaine Taylor, with the literacy interests of REALISTIC I being appended to UTILITY for that portion of this research.

HumRRO research for the Department of the Army is conducted under Contract DAHC 19-70-C-0012. Training, Motivation, and Leadership research is conducted under Army Project 2Q062107A712.

Meredith P. Crawford
President
Human Resources Research Organization

SUMMARY AND CONCLUSIONS

MILITARY PROBLEM

The ability to perform adequately on many military jobs is determined to some extent by the individual's ability to read, listen, or handle arithmetic computations. The content and teaching level of many military training courses and the reading level of many job manuals and other technical materials presupposes literacy levels as high as a college sophomore or higher. Men who are below that level, therefore, can be expected to experience difficulty in using instructional material and manuals in training for or performing their military jobs.

The initiation of Project 100,000 by the Department of Defense in 1966 brought many men of marginal literacy skills into the Armed Services. This influx of men with lower-level language and reading skills strains a training system geared to verbal, lecture-platform types of instruction. Classification of these men into jobs for which their reading skills are sufficient is also a problem, since little information is available concerning the literacy skill levels suitable for a given job. Furthermore, the designation of targeted levels of remedial literacy programs, such as Army Preparatory Training, is performed blindly, since it is not known what level of reading-language skills is needed for adequate job performance.

RESEARCH PROBLEM

Taking cognizance of the literacy problems encountered with the Project 100,000 personnel, manpower planners initiated HumRRO Work Unit REALISTIC. The objectives were to provide information concerning the demands for reading, arithmetic, and listening skills in MOSs composed of large numbers of men, including the "new standards" men of Project 100,000. Also, information was sought concerning utilizing men of low literacy levels through remedial training or modification of job demands.

METHOD

Literacy requirements were studied in four Military Occupational Specialties (MOSs): General Vehicle Repairman (MOS 63C), Unit and Organization Supply Specialist (MOS 76Y), Armor Crewman (MOS 11E), and Cook (MOS 94B). Three methods were used to study the reading level requirements of these jobs.

(1) Relationships were examined between the reading, listening, and arithmetic skills of job incumbents in the above MOSs, and the performance of these men on three different indices of job proficiency: Job Knowledge tests, Job Sample performance tests, and Supervisor's Ratings.[1]

(2) Relationships were examined between reading skills of new Army accessions and their proficiency on job-related reading task tests constructed from printed materials reported by job incumbents to be used in their work as Repairmen, Supply Specialists, or Cooks.

[1] These tests were constructed and administered under HumRRO Work Unit UTILITY.

The materials selected for the reading task tests were identified during interviews with job incumbents in these MOSs. During the interview, information was obtained concerning a man's job-related reading, listening (i.e., acquiring information by asking others), and arithmetic behaviors.

(3) Reading level demands of the printed materials identified as in (2) were estimated by means of a readability formula, and these levels were compared with the reading skill levels of the men in the MOSs.

Additional work on REALISTIC involved considerable laboratory and literature research to obtain information of potential use for reducing gaps that exist between an individual's literacy skill level and the demands of his job for these skills. Much of the laboratory work focused on the study of listening as a substitute for reading, and is reported in HumRRO Technical Reports. Only the results and implications of this laboratory and literature research are discussed in this report.

RESULTS

Concerning literacy demands of jobs, the research indicated that:

(1) Reading ability was related to job proficiency, measured by performance on job-related reading task tests, job knowledge paper-and-pencil tests, and job sample tests. For job reading tasks, the reading test score was more highly related to proficiency than were scores on the Armed Forces Qualification Test (AFQT). For the job knowledge and job sample proficiency tests, AFQT and reading test scores predicted proficiency about equally well.

(2) The reading difficulty of printed job materials (except for the Cook MOS) far exceeded the reading ability of both high and low aptitude men.

(3) If the materials were too difficult, men tended not to use them. The difficulty level of job reading materials was negatively related to the frequency with which they were used on the job.

(4) The greater a man's reading ability, the more likely he was to use printed job materials, even the more difficult materials.

(5) Performance on job sample performance tests tended to improve when manuals were used during the test.

(6) Listening ability was related to job proficiency when measured by either job knowledge or job sample performance tests. In addition:

(a) Category IV personnel said they obtained almost three-fourths of their information by listening.

(b) One-fourth of a sample of some 300 men reported that they preferred to learn by listening rather than by reading; among those identified as very poor readers, the proportion preferring to learn by listening rose to one-half.

(c) A sample of high (Non-Category IV) and low (Category IV) aptitude men learned prose material as well by listening to tapes as by reading.

(d) Men interviewed on the job reported many instances of listening for information. The frequency of listening, relative to reading, was higher for poorer readers in MOSs where reading materials were most difficult.

(7) Arithmetic skill was related to reading, AFQT, and job proficiency when measured by either job knowledge or job sample tests. While arithmetic skills showed

some promise as a predictor of job performance, interviews with job incumbents in the Repairman, Supply Specialist, and Cook fields indicated little actual use of arithmetic on the job. Overall, demands for arithmetic skills did not exceed what is ordinarily taught in the first six grades in school.

(8) Minimal literacy demands were found to be highest for Supply Specialist (ninth grade level), next highest for Repairman and Armor Crewman (eighth grade level), and least for Cook (seventh grade level).

CONCLUSIONS

On the basis of these results, it was concluded that:

(1) Greater use of job reading materials, and hence better job performance, might be stimulated either by upgrading the reading skills of personnel through literacy training, or by reducing the difficulty levels of materials by providing systems-engineered job aids, or both.

(a) If remedial training is given with the aim of providing a closer match between a man's ability and job requirements, suggested targeted grade levels of reading skills are: Cook, seventh grade; Armor Crewman and Repairman, eighth grade; Supply Specialist, ninth grade. Since job requirements differ, remedial training would appear most effective when oriented toward a specific job; general non-job-related literacy training, geared as it is at present in the armed services to a uniform fifth-sixth grade level, would probably not have much effect on job proficiency. Diagnostic literacy tests could be applied to a job area selected by the man prior to his enlistment, both to identify minimal enlistment skills, and to determine the adequacy of the skills for the reading level needed in the job area. Upon accession, men deficient in job-related literacy skills could be given remedial training, using job-related reading, listening, and arithmetic materials, to improve their job proficiency and general military suitability.

(b) Literature research in REALISTIC has indicated that properly designed job manuals can enable the less experienced and less literate men to achieve acceptable job performance, with fewer errors and little or no loss in time, and with much less training than is usually given. The approach to manual design should be "task analytic" with the manual pretested on the prospective user. If materials were redesigned to facilitate job performance of men in the MOSs studied in REALISTIC, it should be expected that men having literacy skills below those identified could use the materials. They could, thus, perform more effectively while receiving remedial literacy training to permit them to move into higher level jobs in which use of general military publications would be necessary.

(2) In view of the fact that the reading test predicts proficiency on job reading tasks better than the AFQT does, and identifies what might be done to remedy a man's skill level, consideration could be given to replacing, or supplementing, the screening instrument (AFQT) with more diagnostic, skills-oriented instruments. Such instruments could serve both as screening tools and as indicators of how much remedial training a man might need in some literacy skill area (reading, arithmetic, listening, writing, speaking) to improve his job proficiency and opportunities.

(3) If elimination, retention, or promotion of incumbents is largely contingent upon job knowledge test performance, formal procedures should be implemented to

ensure that men have opportunities to acquire both the job knowledge and the literacy skills needed to take the test. Skills in reading, listening (if the test is orally presented), arithmetic, or other language/communication may influence test achievement.

(4) Because of the importance of listening, research is needed to study the listening process further and to attempt to improve listening/thinking skills. Such a project, Work Unit LISTEN,[1] is under way at HumRRO Division No. 3 as a follow-up to Work Unit REALISTIC.

[1] HumRRO Work Unit LISTEN, Development of Automated Programs to Improve Listening Skills Required in Army Jobs.

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Determination of Literacy Skill Requirements in Four Military Occupational Specialties

Chapter 1

INTRODUCTION

In 1966, the Department of Defense announced the initiation of Project 100,000. Under this project, the Armed Services began admitting men who were, by previous standards, disqualified for service because of low mental aptitude or, in fewer cases, deficient health standards.

With the implementation of Project 100,000, it was anticipated that there would be an influx of many men of marginal literacy into the services. This was confirmed by statistics (1) which indicated that 31% of a sample of 46,000 Project 100,000 men read at or below the fourth grade level of ability. Some 68% of these low aptitude men read at or below the sixth grade level of ability.

Because of the low literacy skills of many of the Project 100,000 men, there was concern among manpower specialists that many of these "new standards" men might be assigned to jobs wherein the demands for literacy skills might far exceed the ability of the men, and possibly lead to job failure. To reduce this possibility, information about the literacy demands of military jobs was needed. Such information is valuable in making decisions regarding classification of men in job areas, in setting minimal levels required in adult basic education to render a person qualified for a given job, and in determining whether the literacy requirements of jobs might be altered through such measures as redesigning reading materials or providing audio materials. Such redesign of materials could possibly reduce entrance requirements in literacy skills so that individuals deficient in such skills could be effectively utilized, perhaps while receiving training to improve their literacy skills, and thus prepare themselves for higher level job positions.

WORK UNIT REALISTIC

To obtain information concerning the literacy demands of military jobs, Work Unit REALISTIC was initiated in 1968. REALISTIC is an acronym based upon the three literacy skill areas studied—REAding, LIStening, and ArithmeTIC. The objectives of the research were to (a) provide information concerning the demands for reading, listening, and arithmetic skills in several major military occupational specialties (MOSs), and (b) provide information and suggestions for reducing discrepancies between personnel literacy skill levels and the literacy skill levels required by the job.

To determine the literacy requirements of jobs, we used the concurrent validity model, in which both literacy skills and job proficiency measures are assessed concurrently, using as subjects only men currently qualified as job incumbents. The literacy requirement of a job is determined as the minimum literacy competence associated with a specified level of satisfactory job proficiency. If the data contain a range of both literacy and proficiency scores, by using this model the degree of relationship between literacy and job proficiency can be empirically determined. As a concomitant, this model also yields data on the literacy skills characteristic of job incumbents meeting any and all criterion definitions of job proficiency.

However, while the concurrent validity model yields information about the literacy skills of men who are performing their jobs at different levels of proficiency, it provides

no information about the literacy skills of those men lost through attrition during the selection and training processes or reassigned out of the job. To the extent that literacy skills are related to selection, training, and job performance attrition, the concurrent validity model will provide underestimates of the true relationships between predictor variables (literacy, AFQT) and criteria.

For establishing the literacy requirements for job performance, the concurrent validity model is sufficient. For the larger manpower management purpose of selecting and training qualified job incumbents, the concurrent validity model provides only partial data and requires, in addition, a full attrition study of all the potential job performers who never attained or could not retain job incumbency.

DEFINITION OF LITERACY

In applying the model described in the preceding section, relationships between literacy skill levels of job incumbents and various measures of their job proficiency were examined. Before this research procedure is discussed in detail, some general consideration should be given to a definition of "literacy" skill. Most simply, literacy refers to reading ability. Most reading experts today, however, recognize that reading is a *complex* of skills and abilities. It is also generally recognized that reading involves the ability to translate printed symbols into auditory symbols, (i.e., into speech) and that, in the early stages of reading training, most readers silently speak the words on the printed page to themselves. As a reader advances in reading skill, there appears to be less need to sub-vocalize the words, so there is a more direct decoding of printed symbols into meaning.

The fact that listening ability typically precedes reading ability, and that the reading process is usually built upon a structure of listening ability was of particular concern. It was conjectured that some lower aptitude men might not be able to learn a job well by reading, but would be able to learn by listening or by demonstration. Their primary literacy defect might be one of lack of skill in decoding printed symbolism into speech. Thus, listening skill was included in the research as a subcomponent of "literacy."

As a matter of secondary interest, and at the request of the sponsor, arithmetic skill was included in the study as a measure of a specific literacy skill, consisting of the ability to receive and process information in a highly specific, formal, and rigorous language. Budget and time constraints precluded the study of the expressive literacy skills of speaking and writing.

RATIONALE FOR THIS RESEARCH

The question may be raised as to why one might expect to find relationships between literacy skills and job proficiency. The REALISTIC research was premised on the idea that language skills (including reading and listening) are primary means of learning about job tasks, their requirements, and how to accomplish them. Thus, in the formal training programs which precede most jobs, information (vicarious experience) is acquired in large part through reading and/or listening. Then, in day-by-day performance of the job, some tasks (e.g., reading manuals and forms) are inherently reading tasks, while many others, which make no immediate demands on reading skills, may have been previously learned by reading, and hence have an indirect requirement for reading.

Other job tasks, however, may be learned by asking co-workers or supervisors. Such tasks, while not demanding reading skills, make a demand on listening skills. Thus, one

can expect that, to the extent that job tasks make past or present demands on language skills, their successful performance will be related to some degree to measures of literacy skill.

Yet, it must be emphasized that being able to exercise literacy skills to obtain information about what to do and how to do it is only one (complex) factor in the set of factors (e.g., personality, attitudes) that determine job proficiency. For this reason it was not expected that knowledge of literacy skills would account for all, or even the greater part of, the differences in job proficiency observed in a broad spectrum of job incumbents.

OVERVIEW OF WORK UNIT REALISTIC

In pursuing the objectives stated above, research on REALISTIC was undertaken in three Work Sub-Units (Figure 1). The effects of literacy on job proficiency were examined by studying relationships among the reading, listening, and arithmetic skills of personnel and their performance on one or more of four different measures of job proficiency. As Figure 1 indicates, the indices used included proficiency on job-related reading tasks, proficiency on hands-on Job Sample performance tests, proficiency on Job Knowledge paper-and-pencil tests, and proficiency as measured by supervisor ratings.

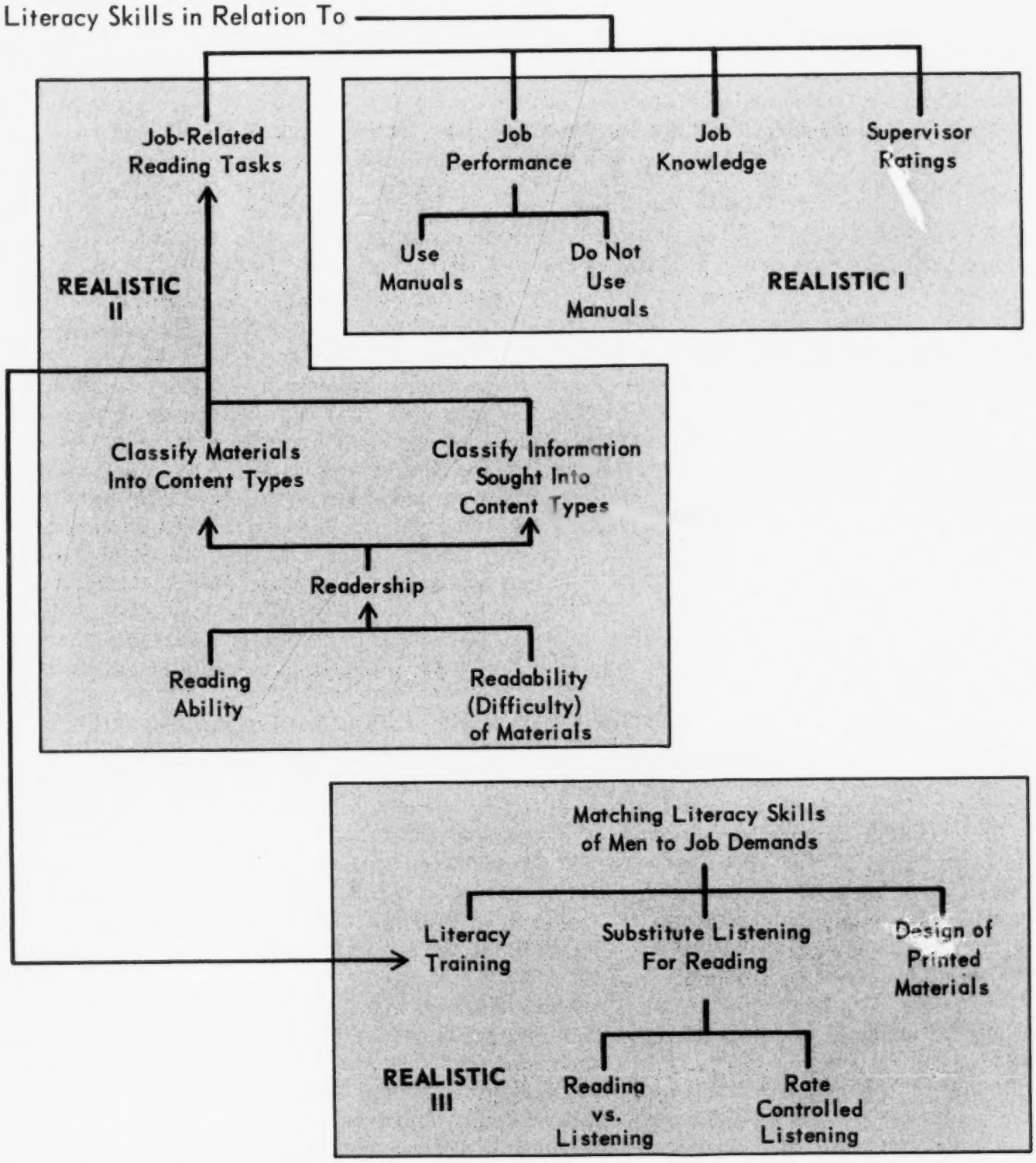
Relationships between literacy skills and proficiency on the job performance test, knowledge test, and supervisor ratings were studied under Sub-Unit REALISTIC I.[1] Relationships between literacy skills and performance on job-related reading tasks were explored under Sub-Unit REALISTIC II. Figure 1 reflects the activities used to identify job-related reading tasks and provide information concerning how a man's reading ability interacts with the reading difficulty level of job reading materials to influence the extent of their use.

An additional direction of effort in REALISTIC III was to identify information that provides a basis for reducing gaps which may exist between an individual's literacy skill level and the demands of the job for these skills. This activity involved some experimental work, primarily in regard to listening, but was mainly based on a literature survey. As indicated in Figure 1, reduction of discrepancies between the skills people have and the skills needed for the job was to be considered either by modifying the person through literacy training, or by modifying the job demands through the substitution of listening for reading demands, and the redesign of job and training aids to make them less demanding of literacy skills. Work on REALISTIC III is described in more detail in works on listening in relation to aptitude (3,4).

In the Chapters which follow, research dealing with how reading ability, with its attendant language component, may exercise a pervasive influence on a man's information seeking and processing on the job is described first (Chapter 2). Following the examination of the on-the-job reading practices of men in selected jobs, consideration is given to the relationships observed between reading ability and proficiency on job reading tasks (Chapter 3). Chapter 4 describes the relationships between literacy skills and the three job proficiency indices studied in Sub-Unit REALISTIC I. Chapter 5 discusses methods for reducing gaps between literacy demands of jobs and literacy skills of personnel. Finally, Chapter 6 summarizes the research findings and their implications for personnel selection, classification, and training, and for design of job aids to facilitate job performance.

[1] The work on REALISTIC I was performed in conjunction with HumRRO Work Unit UTILITY and shared the same subjects (*cf.* 2).

Organizational Chart for Work Unit REALISTIC



In Sub-unit REALISTIC I, literacy skills are related to job performance, knowledge, and supervisor ratings. In REALISTIC II, literacy skills are related to job-related reading tasks. In REALISTIC III, methods of matching literacy skills of men to literacy demands of jobs are considered.

Figure 1

Chapter 2

LITERACY AND ON-THE-JOB READING BEHAVIOR

The data in this chapter show how the difficulty level of printed job materials and the level of the reader's skill may interact to influence the extent of use of job reading materials. Data also show how reading ability relates to the practice of asking and listening to others for job-related information, and to the extent and nature of usage of arithmetic on the job. These data were collected under REALISTIC II in the course of identifying job reading materials for use in the construction of job reading task tests.

Three Army jobs were studied: General Vehicle Repairman (MOS 63C), Unit and Organizational Supply Specialist (MOS 76Y), and Cook (MOS 94B). These jobs were selected for study because they represent a range of literacy demands as determined from the job requirements stated in AR 611-201.[1] These jobs were included in both REALISTIC I and Work Unit UTILITY; thus, there is a comprehensive base of knowledge about the jobs and about the men working in them.

THE STRUCTURED INTERVIEW

Job-related reading materials were identified by means of a structured interview administered to men in the target MOSs at their job locations. In addition to personal data, such as name and unit, information was obtained regarding the use of listening and reading sources in obtaining job-relevant information, and the nature and frequency of use of arithmetic skills.

To identify use of listening sources the man was asked to give five instances when he had asked somebody for job-related information in the last month or so. Probing was continued until he could not think of any more instances.

A similar procedure was employed to identify use of printed materials or reading sources. The man was asked to give five examples of times, during the past month or so, when he had used printed materials in connection with performing a job. In each case he was asked to describe the job he had been performing and to tell what information he had been seeking when he went to the printed material. He was asked to get the manual, locate the exact page he had used, and then show the interviewer the specific parts of the material he had used in obtaining the desired information. This process was repeated until either five instances had been described or the individual could give no more; in any event, he was not pressed for examples beyond five in number.

A similar procedure was used to elicit comments about the use of arithmetic. An attempt was made to get at least five citations of the use of arithmetic. The type of task performed using arithmetic was noted, and the type of arithmetic (i.e., addition, subtraction, etc.) was determined from the nature of the tasks reported.

[1] Department of the Army. *Manual of Enlisted Military Occupational Specialties*, Army Regulation 611-201, Washington, April 1966, with amendments.

SUBJECTS

Men in the REALISTIC II research were selected on the basis of reading grade level scores, with the additional requirement that their total time in the job fall between one and 18 months. Because of entry training and leave time, 18 months tends to be the uppermost limit for individuals serving the standard draftee's two-year tour of duty. Thus the data refer to men serving in their jobs for a period of time no greater than a single tour of duty.

In order to select potential interviewees on reading grade level scores, it was necessary to first schedule special testing sessions and administer the reading achievement test. Since it was not feasible to administer reading tests to all men who were serving in the target job positions at a given installation, it was necessary to prescreen from available personnel records with the hope that the desired number who qualified within each of the three reading levels would be obtained. This prescreening was accomplished by selecting for reading testing only those who had between one and 18 months of job experience and by selecting equal numbers of men whose Armed Forces Qualification Test (AFQT) scores fell between 0-20, 30-50, and 51-100. While the exact AFQT category limits used were somewhat arbitrary, the general rationale for defining groups was based on results of previous studies. In these studies correlations between AFQT and the reading achievement test averaged approximately .65 (see also Chapter 4).

Table 1 shows the number of men interviewed at each reading level interval for each of the three job positions. This table also shows the means, and standard error of the means, for the AFQT scores and the reading grade level scores of each reading level

Table 1

Descriptive Data on Men Interviewed in Each of the Three Job Positions

MOS	N	AFQT		Reading Grade Scores [a]	
		Mean	Standard Error	Mean	Standard Error
Supply Specialist					
High Reading Level (9.0+)	11	73.8	5.0	11.2	0.4
Middle Reading Level (7–8.9)	9	36.0	3.2	7.7	0.1
Low Reading Level (4–6.9)	10	17.4	3.0	6.3	0.2
	30				
Repairman					
High Reading Level (9.0+)	25	45.2	4.4	10.1	0.2
Middle Reading Level (7–8.9)	34	33.3	2.7	7.9	0.1
Low Reading Level (4–6.9)	26	24.7	2.5	6.1	0.1
	85				
Cook					
High Reading Level (9.0+)	15	63.6	3.8	11.2	0.4
Middle Reading Level (7–8.9)	16	35.1	3.6	8.0	0.2
Low Reading Level (4–6.9)	17	24.7	4.1	5.4	0.4
	48				

[a]Survey of Reading Achievement, Junior High Level, California Test Bureau.

subgroup. Because of the high correlation of AFQT and reading, the effects of AFQT on reading ability were not removed by either statistical or design procedures, as doing so would, in effect, nullify the results of the study. Thus, in the analyses which follow, the low reading groups (4-6.9) consist primarily of men with AFQTs from 10-30 (AFQT Mental Category IV), while the men in the higher reading groups have AFQTs of 31 or greater (AFQT Categories III, II, and I).

DIFFICULTY OF JOB-RELATED PRINTED MATERIALS IN RELATION TO READING ABILITY

One way to assess the reading requirements for a job is to examine the reading materials used by men on the job. If, according to the current, formal job specifications, a job incumbent is expected to be able to read certain publications, then an evaluation of the difficulty level of these publications provides an estimate of level of reading skill required by the job. Thus, in the present research, one of the questions of interest concerned the reading difficulty levels of the reading materials cited by the men as having been used in conjunction with their job activities.

To determine these difficulty levels, copies of the publications cited during the interview were obtained. For the Repairman and Cook MOSs, copies of publications which were cited five or more times were obtained. For the Supply Specialist MOS, where there were few publications cited, the researchers obtained a copy of the most frequently cited reference and copies of a number of other publications which were reported by supply sergeants to be of importance and in general use in the supply field.

The modified Flesch readability formula developed by Farr, Jenkins, and Paterson (5) was used to assess the reading difficulty levels of the job publications. The term "readability" refers to the comprehensibility of a publication—that is, how easy it is to read and understand it.

The readability analyses are summarized in Table 2, which shows the total number of publications and pages sampled in each MOS, the range of reading difficulty levels found over all pages, and the average grade level or readability of materials in the MOSs.

Table 2

Readability Scores for Publications in Three Army Jobs

MOS	Number of Publications	Number of Pages Sampled	Range of Flesch Readability Levels – SGE[a]	Average Readability SGE[a]
Supply Specialist	11	64	8.5 – 16+	16+
Repairman	8	244	7.0 – 16+	14.5
Cook	6	100	6.0 – 14.5	9.0

[a] SGE = School Grade Equivalent

The average grade level of readability of materials is shown graphically in Figure 2. Included also is an indication of the average reading grade level scores of a sample of Army personnel working on jobs within each of the MOSs (these data were obtained in the course of the work on REALISTIC I which is described later in the report). The reading ability data are provided separately for high aptitude (non-Category IV) and low aptitude (Category IV) men.

Readability of Publications and Reading Ability of Job Incumbents

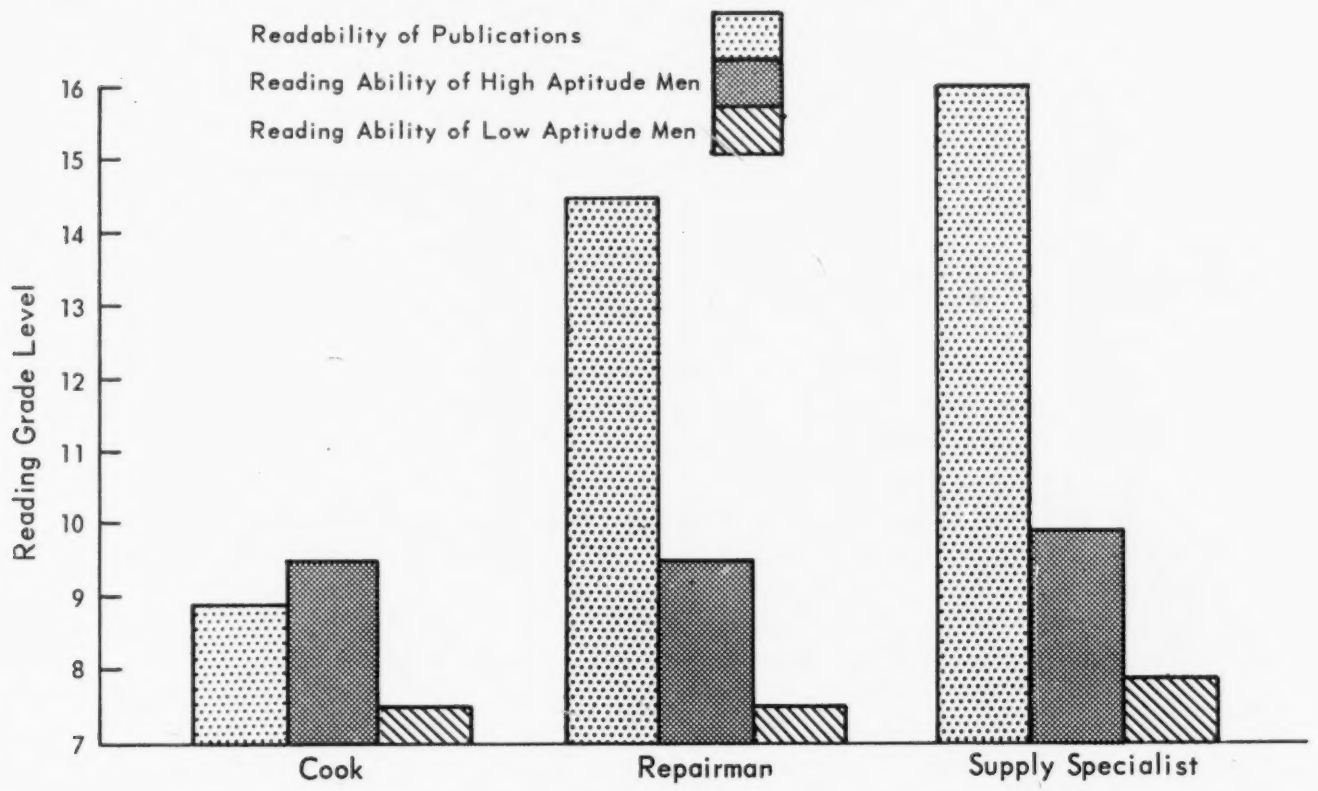


Figure 2

Making the visual comparisons between readability and reading ability suggested in Figure 2, it is noted that the difficulty level of printed materials for the Supply Specialist and Repairman positions exceeds the average reading achievement levels of the high aptitude job incumbents by about five to six grade levels. For the Cook job, however, difficulty level of the printed job materials and the reading achievement level of the high aptitude personnel are almost numerically matched. The low aptitude Cooks present an average reading achievement level that falls only about two grade levels below the reading difficulty level of their materials. Since the readability formula provides a roughly accurate index of the difficulty of the materials, Figure 2 suggests that both high and low aptitude personnel would experience considerable difficulty in reading and comprehending the Supply and Repairman job materials.

READABILITY, READING ABILITY, AND READERSHIP

In the fields of journalism and advertising, the effects of the reading difficulty level of materials on the readership of the materials has been examined. Such study has indicated that, if materials are written at too high a level of difficulty, the number of people who read them may drastically decline. For this reason it was of interest to find out whether the gap between the reading ability of the men in an MOS and the reading difficulty level of the job printed materials might influence the extent to which men reported the use of job-related reading materials. It was thought that men of poorer reading ability might avoid reading material and instead tend to listen or ask for job information to a greater extent than the more able readers.

Data bearing on the readership and extent of listening are presented in Figure 3 for men of three reading skill levels and for Supply Specialist, Repairman, and Cook jobs. The readership index expresses the number of printed citations as a percentage of the maximum number possible if each man had given his full limit of five. Thus, a readership index of 20 means that the particular group of men produced, on the average, one citation of the use of printed material out of a possible five requested; an index of 40 would mean they produced an average of two printed citations out of the five requested, and so on. The listening index was computed in the same manner as the readership index by presenting the number of listening citations actually reported as a percentage of the maximum number of citations possible.

Citation of Reading and Listening Information Sources by Reading Ability Level

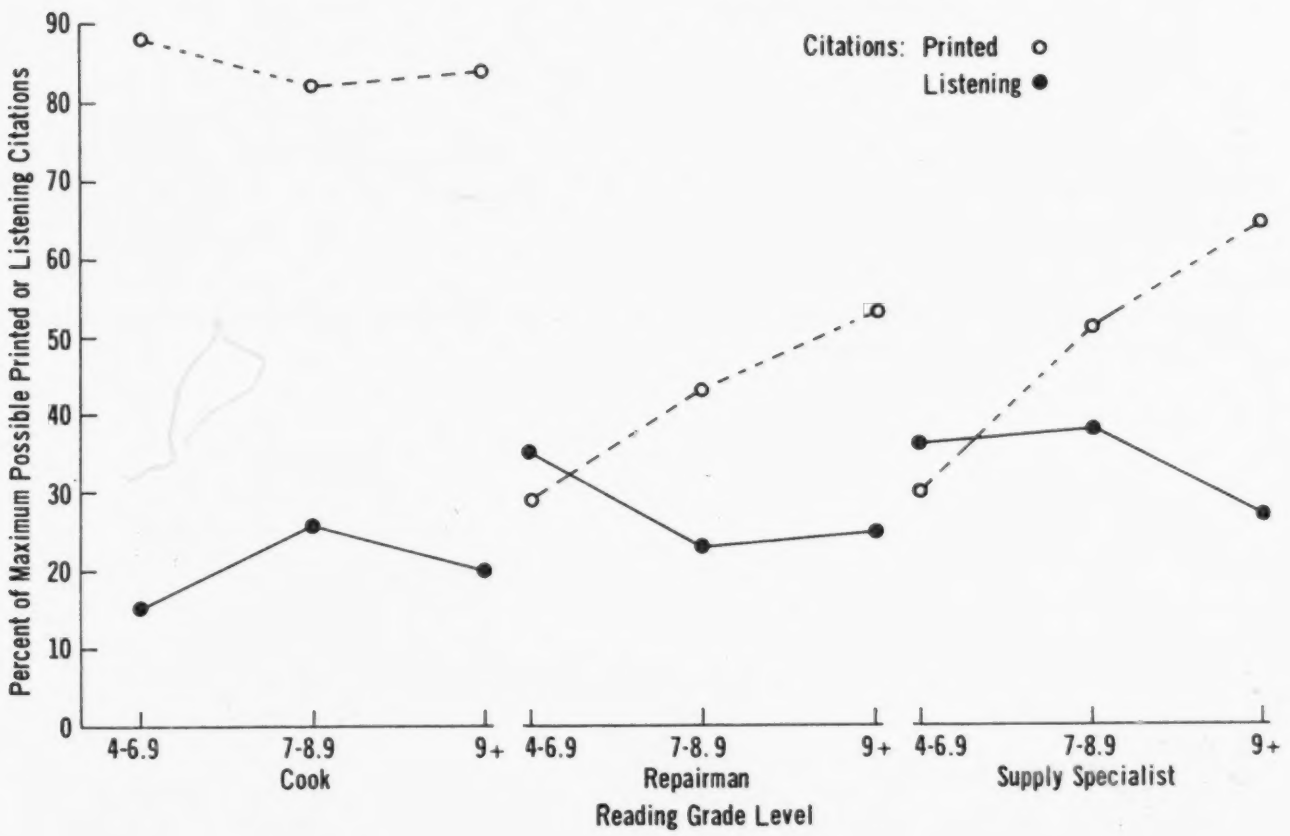


Figure 3

Statistical analyses (Appendix A) and the data of Figure 3 indicate that for the Supply Specialist and Repairman a clear relationship exists between reading ability and the reported use of job related materials—the more able the reader, the greater the reported use of printed materials. For Supply Specialist, readers in the grades 4-6.9 reading group gave only 30% of the maximum possible citations of use of printed materials, contrasted with nearly 65% of maximum citations for the group of readers in the grades 9+ range. For Repairman, the readership increased from 30% to 50% of maximum as a function of reading ability. It is notable that the Cook group reported a high (>80%) incidence of use of printed materials, and this was independent of reading ability. A possible reason for this will be discussed later.

The data for listening indicate a fairly constant use of listening over the three level groups in each MOS. In the Supply Specialist and Repairman MOSs the listening index is slightly higher than the readership index for the lower reading groups. However, with these small groups, these differences are not statistically reliable.

The data show a remarkable degree of consistency. In addition, the relationships observed among reading ability, readability, readership, and listening appear to follow a logical course. When reading materials are difficult, as in the Repairman and Supply Specialist jobs, there is less tendency for readers of any level to use the materials, although the men of higher reading ability will use them more than the less able readers. If the job materials are quite difficult, and the man cannot read very well, he may seek proportionately more of his information from others, rather than from reading the job materials.

While these data indicate that better readers are more likely to use manuals, the question still remains as to whether the use of manuals aids job performance. Data concerning reading ability, the use of manuals, and *job performance* were obtained in REALISTIC I (described in greater detail in Chapter 4). In that research, job incumbents were administered three- to five-hour Job Sample tests in which Repairmen actually repaired vehicles and Supply Clerks worked in simulated offices filling out forms and counting equipment. In these Job Sample tests, job manuals were available so that men who were being tested could use the manual if they wanted. Figure 4 shows relationships

Job Sample Test Performance as a Function of Reading Ability and Use of Technical Manuals

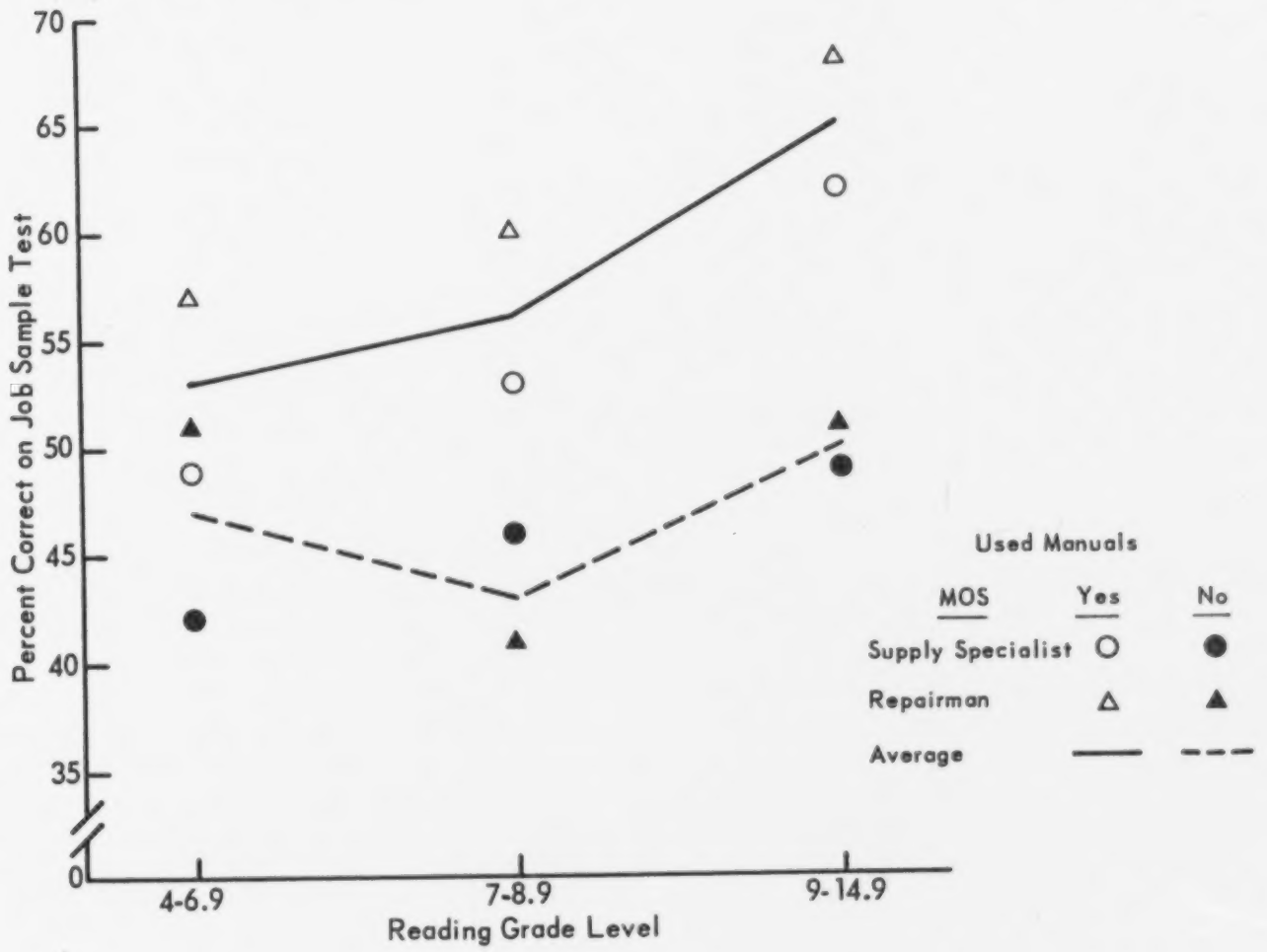


Figure 4

between reading ability, use or non-use of manuals, and performance on the Job Sample tests for Supply Specialists and Repairmen. It is apparent that men who use manuals did better than those who did not use manuals regardless of reading ability. Furthermore, of those who used manuals, performance was better for the more highly literate men.

The present data on readability, reading ability, and readership across the three MOSs suggest that greater usage of job reading materials might be stimulated both by improving literacy skills of the men and by the redesign of reading materials. Furthermore, the data for the Cook MOS suggest that greater gains in readership might be expected from the redesign of materials than from increasing the literacy skills of men. In this regard, much research on the construction and evaluation of various job performance aids has indicated that by following a systems approach, materials printed for the job can be designed which greatly improve the effectiveness of job incumbents across a spectrum of aptitude. It seems likely that the provision of such aids would also increase the utilization of job printed materials.

READING ABILITY AND USE OF ARITHMETIC ON THE JOB

Table 3 summarizes the data on the use of arithmetic in these jobs. The arithmetic citations, like the readership and listening index numbers, are stated in terms of percentage of possible citations. Table 3 also indicates the nature of the arithmetic comprising the citations made by men. Thus, Repairmen with a reading level of 9+ gave only 15% of the maximum possible citations of the use of arithmetic. Of these few citations, 5% involved the use of whole numbers, another 5%, decimals or fractions, 27%, some system of measurement (i.e., a money system, changing inches to feet, pounds to ounces) and 63%, the use of a measurement tool (such as a ruler or a gauge). In the Repairman job, the use of gauges (torque wrenches, air pressure gauges, etc.) represented the primary use of arithmetic.

Of special note in the Supply Specialist job is the lower incidence of use of whole numbers by higher reading ability men, and their higher frequency of use of a system of measurement. The data indicate that the higher reading ability men tend to work more

Table 3

Use of Arithmetic as a Function of Reading Ability

(Use of Arithmetic is in Percent of Maximum Citations Possible)

MOS	Reading Level	Arithmetic Citations (Percent)	Percent of Citations Using:			
			Whole Numbers	Decimal/ Fractions	System of Measure	Measurement Tool[a]
Repairman	9+	15	5	5	27	63
	7–8.9	6	9	0	27	64
	4–6.9	9	8	0	0	92
Supply Specialist	9+	38	32	9	54	5
	7–8.9	33	73	0	27	0
	4–6.9	28	71	0	29	0
Cook	9+	32	33	0	63	4
	7–8.9	29	35	0	65	0
	4–6.9	33	29	0	68	3

[a]Ruler, gauge

with the money system in the Supply MOS than do the less able readers. The latter in turn do mostly simple counting tasks involving whole numbers. The Cook job data bear out the importance of systems of measurement in the use of recipe books. This was true regardless of reading level.

Overall then, these data indicate a fairly low usage of arithmetic in these jobs. When used, however, the nature of the arithmetic task is likely to be different for each MOS, and, in the case of the Supply Specialist, for different reading ability groups. Thus we find that Repairmen use mostly gauges, while Cooks use the measurement systems involved in preparing recipes. In the Supply Specialist MOS, men of low or average reading ability do simple counting, and men of higher reading ability work with the money system and accounting.

Chapter 3

READING SKILLS RELATED TO PROFICIENCY ON JOB READING TASK TESTS

The primary objective of Sub-Unit REALISTIC II was to identify job reading tasks and to evaluate the relationships of performance on job reading task tests to performance on a standardized reading achievement test.

To construct reading task tests it was first necessary to define and identify job reading tasks. A job reading task was defined as a task in which a person obtains (or attempts to obtain) information about a job by reading from a manual, book, form, or other job-related printed material. Job-related printed material is, by definition, material which presents information about the various tasks comprising a job. Hence a job reading task involves a piece of reading matter which presents some job information and a reader who attempts to use the reading matter to obtain the job information.

With the foregoing task definition in mind, job reading materials were identified by means of a structured on-the-job interview. As mentioned earlier, each man was asked to cite five instances in which he had used printed materials in his work in the last month or so. He was also asked to locate the printed material, show the interviewer the exact page and section he had used, and tell what kind of information he had been seeking.

With this information, it was possible to subsequently obtain copies of the printed materials cited as being used on the job by the men in the three MOSs (Supply Specialist, 76Y; Repairman, 63C; Cook, 94B). With these materials in hand, a classification scheme was devised by which each page or section of reading materials cited in each MOS could be classified in terms of the type of information it displayed. This type of information is referred to as the *content type* of printed material. The classification system used for categorizing the various materials is given in Table 4.

In using this classification scheme to construct reading task tests, the printed materials cited by the men in each MOS were sorted into the six different content categories. Setting aside Category I (Tables of Content and Indexes), materials in the remaining five categories were sorted, independently, by two judges, who in their initial judgments agreed on 87%, 80%, and 96% in the Repairman, Supply Specialist, and Cook jobs, respectively.

In the process of sorting materials, however, problems in the classification scheme became apparent. What should the unit of classification be based upon—a sentence or two, a paragraph, or a major sub-section of a technical manual? How should pictorial materials be classified? Such questions indicate the difficulties involved in classifying printed materials. To expedite the present research, we classified materials on the basis of the major subsection of a publication. Thus a section which gave the procedures for filling out a form was classified *Procedural Directions*, even though there may have been standards and specifications given in the context of the material.

In addition to identifying job reading materials, the interview provided data about the nature of the information a man had been seeking when he used the material—in other words, the kinds of questions men working on the job addressed to the job reading materials.

Table 4

Definition of Content-Type Categories

1. **Tables of Content and Indexes:**
   Content designating the location of information within a publication.

2. **Standards and Specifications:**
   Content setting forth specific rules or tolerances to which task procedures or the completed product must conform.

3. **Identification and Physical Description:**
   Content attempting to symbolically represent an object via an identifying code (stock number, nomenclature) and/or by itemizing its distinguishing physical attributes.

4. **Procedural Directions:**
   Content which presents a step-by-step description of *how* to carry out a specific job activity. Essential elements are equipment/materials/ingredients to be used, and how they are to be used, with presentation organized in a sequential step-wise fashion.

5. **Procedural Check Points:**
   Content which presents a key word or highly summarized version of *what* should be done in carrying out a task rather than how it should be done. This content differs from the content classified under Procedural Directions in that it assumes the user knows how to carry out the steps once reminded that the step exists and/or reminded of the decision factors which determine whether the step is required.

6. **Functional Description:**
   Content which presents an operating (cause and effect, dependency relationships) description of some existing physical system or subsystem, or an existing administrative system or subsystem.

From this information, and copies of the printed materials cited as being used on the job by the men in the three MOSs, job-related reading task tests were constructed. These tests represented the most frequently mentioned reading material content types, and required the man being tested to seek the kind of information from the materials which job incumbents reported seeking. Three separate tests were constructed, each using job-specific, MOS materials.

The general nature of the reading task tests is shown in Figure 5, using a portion (the Index) of the Cook Reading Task test. As indicated, questions about the job reading material were presented on the right side of the test booklet and the job-related reading materials were presented on the left side of the booklet. This construction was similar for all subtests in the job reading task test for each job.

Sample from the Cook Reading Task Test

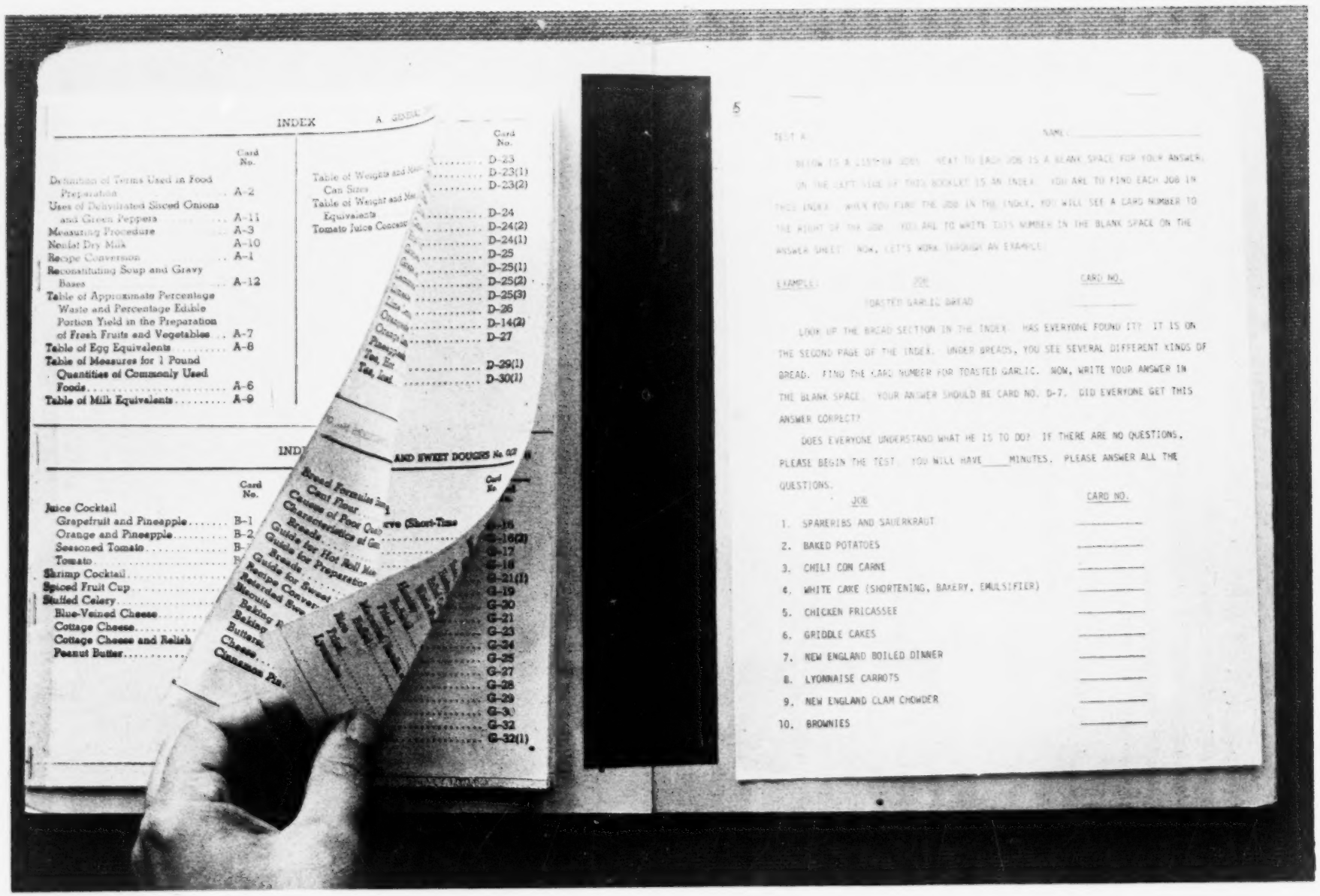

INDEX
Card No.
Definition of Terms Used in Food Preparation ... A-2
Uses of Dehydrated Sliced Onions and Green Peppers ... A-11
Measuring Procedure ... A-3
Nonfat Dry Milk ... A-10
Recipe Conversion ... A-1
Reconstituting Soup and Gravy Bases ... A-12
Table of Approximate Percentage Waste and Percentage Edible Portion Yield in the Preparation of Fresh Fruits and Vegetables ... A-7
Table of Egg Equivalents ... A-8
Table of Measures for 1 Pound Quantities of Commonly Used Foods ... A-6
Table of Milk Equivalents ... A-9
Table of Weights and ... D-23
Can Sizes ... D-23(1) D-23(2)
Table of Weight and ... Equivalents D-24
Tomato Juice Concen ... D-24(2) D-24(1)
... D-25 D-25(1) D-25(2) D-25(3)
... D-26 D-14(2) D-27
Pineapples ... D-29(1)
Tea, Ice ... D-30(1)
Tea, Inst
AND SWEET DOUGHS No. 02
Juice Cocktail
Grapefruit and Pineapple ... B-1
Orange and Pineapple ... B-2
Seasoned Tomato ... B-
Tomato ... B-
Shrimp Cocktail ...
Spiced Fruit Cup ...
Stuffed Celery ...
Blue-Veined Cheese ...
Cottage Cheese ...
Cottage Cheese and Relish ...
Peanut Butter ...
Bread Formula
Cereal Flour
Causes of Poor Qual
Characteristics of Go
Breads
Guide for Hot Roll Mix
Guide for Preparation
Breads
Guide for Sweet
Recipe Conver
Retarded Swe
Biscuits
Baking P
Baking
Butters
Cheese
Cinnamon Pin
ve (Short-Time
G-16
G-16(2)
G-17
G-18
G-21(1)
G-19
G-20
G-21
G-23
G-24
G-25
G-27
G-28
G-29
G-3
G-32
G-32(1)
5
TEST A
NAME:
BELOW IS A LISTING OF JOBS. NEXT TO EACH JOB IS A BLANK SPACE FOR YOUR ANSWER. ON THE LEFT SIDE OF THIS BOOKLET IS AN INDEX. YOU ARE TO FIND EACH JOB IN THIS INDEX. WHEN YOU FIND THE JOB IN THE INDEX, YOU WILL SEE A CARD NUMBER TO THE RIGHT OF THE JOB. YOU ARE TO WRITE THIS NUMBER IN THE BLANK SPACE ON THE ANSWER SHEET. NOW, LET'S WORK THROUGH AN EXAMPLE:
EXAMPLE: JOB: CARD NO.
TOASTED GARLIC BREAD
LOOK UP THE BREAD SECTION IN THE INDEX. HAS EVERYONE FOUND IT? IT IS ON THE SECOND PAGE OF THE INDEX. UNDER BREADS, YOU SEE SEVERAL DIFFERENT KINDS OF BREAD. FIND THE CARD NUMBER FOR TOASTED GARLIC. NOW, WRITE YOUR ANSWER IN THE BLANK SPACE. YOUR ANSWER SHOULD BE CARD NO. D-7. DID EVERYONE GET THIS ANSWER CORRECT?
DOES EVERYONE UNDERSTAND WHAT HE IS TO DO? IF THERE ARE NO QUESTIONS, PLEASE BEGIN THE TEST. YOU WILL HAVE ____ MINUTES. PLEASE ANSWER ALL THE QUESTIONS.
JOB CARD NO.
1. SPARERIBS AND SAUERKRAUT
2. BAKED POTATOES
3. CHILI CON CARNE
4. WHITE CAKE (SHORTENING, BAKERY, EMULSIFIER)
5. CHICKEN FRICASSEE
6. GRIDDLE CAKES
7. NEW ENGLAND BOILED DINNER
8. LYONNAISE CARROTS
9. NEW ENGLAND CLAM CHOWDER
10. BROWNIES

Figure 5

Table 5 lists the subtests in each job reading task test. The variety in the three job reading task tests reflects the variety of different content types cited by men in the different jobs. Also given is the difficulty level, in terms of the modified Flesch readability formula (5), of both the job material and the test material, where it was possible to compute the readability index. In all measurable cases, the difficulty level of the materials exceeded that of the test questions.

Table 5

Content Types and Difficulty Levels of Job Reading Task Test Materials and Test Questions

Job	Test	Content Type[b]	Reading Difficulty Level[a]	
			Job Material	Test Questions
Repairman (MOS 63C)	A	1	NA	8.5
	B	2	NA	8.5
	C	4	14.5	8.5
	D	4	NA	8.5
	E	4	14.5	11.0
	F	6	16+	NA
	G	5	14.5	8.5
Supply Specialist (MOS 76Y)	A	1	NA	6.0
	B	2	NA	8.5
	C	3	NA	7.0
	D	4	16+	11.0
	E	5	8.5	7.0
Cook (MOS 94B)	A	1	NA	5.0
	B	4	NA	7.0
	C	4	7.0	6.0
	D	4	8.5	6.0

[a]Readability levels in school grade equivalents (see text).
[b]Content Types follow the numbering in Table 4.

READING ABILITY RELATED TO READING TASK PERFORMANCE

Relationships of general reading ability to performance on the job reading task tests were evaluated by administering the Job Reading Tests (JRT) and a Standardized Reading Test (SRT) (described in Chapter 4) to several hundred Army inductees at the Reception Center at Fort Ord. In administering the JRT, the directions were read aloud and the example was worked through by the examiner, proctor, and the subjects together. The number of subjects per testing session ranged from 25 to 45.

Table 6 shows the relationships of performance on the JRT to both the SRT and AFQT measures. AFQT related equally closely (r=.65) to the job-specific reading material of the JRT and to the more general reading content of the educationally oriented SRT. There is similarly a notable consistency in the higher level of relationship (mean r=.77) between the general reading measure (SRT) and the job-specific reading test (JRT) in each of the three MOSs.

Table 6

Correlation Coefficients Showing Degree of Relationship of Reading Ability and AFQT to JRT Performance

Test	Job-Related Reading Task Test: New Army Personnel					
	Repairman		Supply Specialist		Cook	
	r	N	*r*	N	*r*	N
Standardized Reading Test[a]	.76	200	.78	222	.77	193
AFQT	.66	199	.65	221	.64	191

[a] The correlation between AFQT and Standardized Reading Test scores for these personnel is .65.

Figure 6 shows the percentage of men tested at a reception station who are at or above three different criterion levels of performance on the JRT in relation to the reading ability level of the men as determined by the SRT. This provides an indication of the level of reading skills required to perform job reading tasks.

The vertical broken line in each section of Figure 6 designates a reading skill level of 8.0, a level frequently referred to as *functional literacy* (a considerable increase from the 4.0 grade level of functional literacy established in World War II). The data for the Cooks show that 100% of the people who read at the eighth grade level would pass the criterion score on the Cook reading test whether this criterion was set at 50%, 60%, or 70% correct. For the Repairman reading tasks, however, of those reading at the 8.0 level only 70% would be expected to surpass the 70% correct criterion level. For the Supply reading tasks, the situation worsens, since only 20% of persons with a reading level of 8.0 would be expected to get 70% correct. Thus there are clear differences in the reading skills needed for men not trained in the job to use the printed materials from the three MOSs. This is discussed in the next section.

READABILITY OF MATERIALS AND READING TASK PERFORMANCE

The foregoing analyses substantiate the data on the difficulty of materials presented earlier in this report, where it was indicated that the reading difficulty of the Supply material was higher than that of the Repairman, which in turn was more difficult than that of the Cook (Figure 2). The data for job reading task performance (Figure 6) appear to substantiate the readability data, in that the Cook's material appears to impose less difficulty than the Repairman's, which in turn is less formidable than that of Supply.

With regard to job reading material, then, the need for advanced reading skills appears to be greatest for the Supply Specialist job, with the Repairman and the Cook jobs following in that order. If one were to consider a functional reading level to be one at which 80% of the readers would be expected to get 70% of the job reading task items correct, then functional literacy for Cooks would be in the range of grade levels 7.0 – 7.9, for Repairmen, 8.0 –8.9, and for Supply Specialists, 12 – 12.9.

It is likely, however, that through Advanced Individual Training in an MOS area, classification factors, learning of relevant technical terms, and familiarity with the job materials will permit less able readers to use the job materials more satisfactorily.[1]

[1] Additional data bearing on this problem are being collected under HumRRO Work Unit READNEED.

Men at Each Reading Grade Level Reaching Different Criterion Levels on Reading Task Test *(percent)*

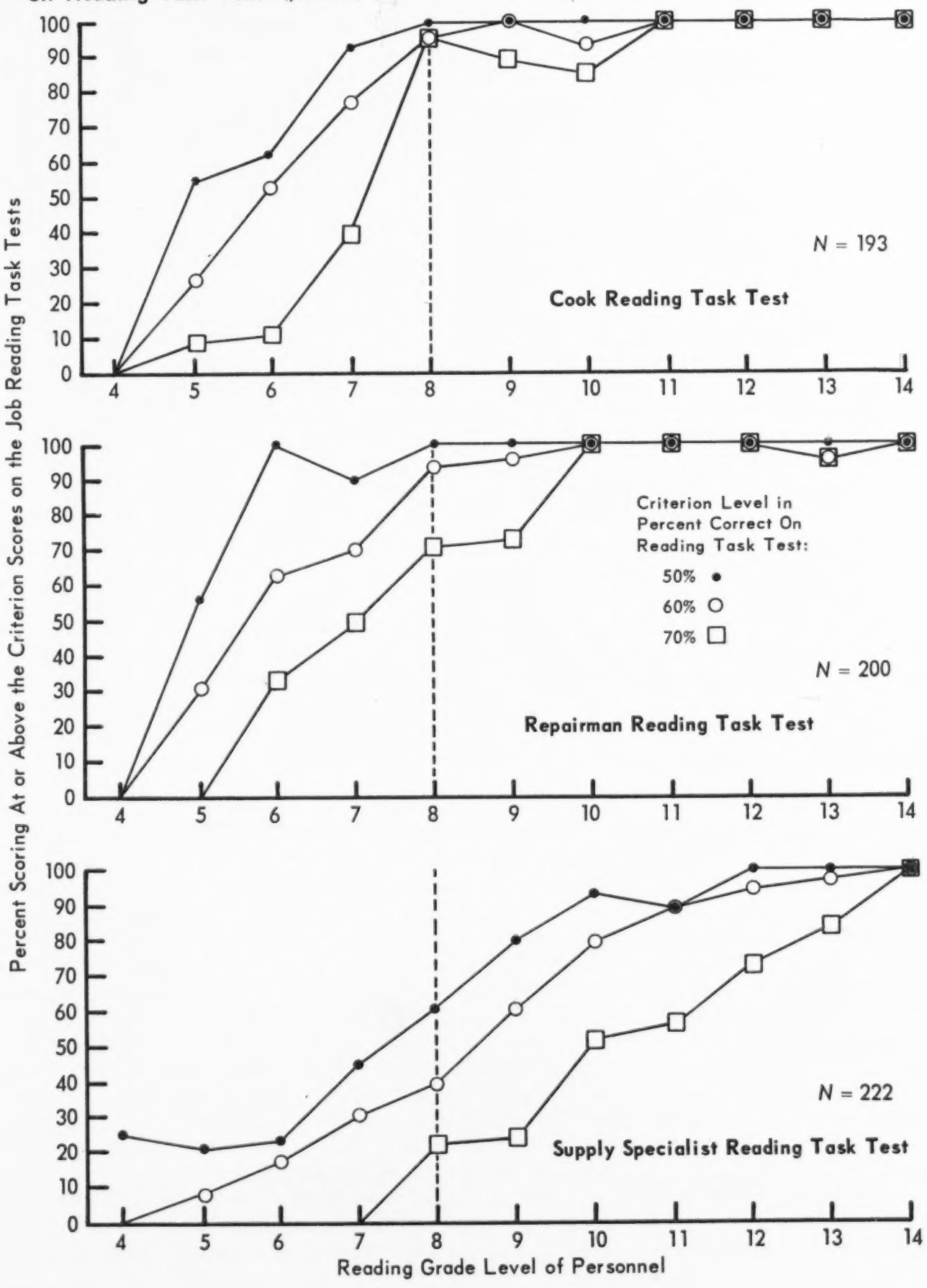


Figure 6

Chapter 4

LITERACY IN RELATION TO JOB KNOWLEDGE, JOB PERFORMANCE, AND SUPERVISOR RATINGS[1]

In Chapter 3 relationships between performance on job reading task tests and on a standardized reading achievement test were examined. For Repairman (MOS 63C), Supply Specialist (MOS 76Y), and Cook (MOS 94B), correlation coefficients for job reading task performance and performance on the standardized reading test were fairly large. This was not unexpected, inasmuch as both tests were explicitly designed to tap reading skill, with the purpose of identifying levels of reading skills needed to adequately utilize job reading materials.

This chapter is directed toward the examination of relationships between three literacy variables (reading, listening, arithmetic) and three indexes of job proficiency which were *not* designed to tap reading skills, at least not in a direct manner. The job proficiency indexes include: job knowledge (paper-and-pencil tests), job performance (hands-on job sample tests), and supervisor ratings.

It was anticipated that reading skill would be more highly related to the paper-and-pencil tests than to the job sample performance tests. It was also expected that substantial relationships might be found between hands-on performance tasks and literacy skills because both require some degree of language facility. However, in the case of job sample performance, it was recognized that (as data reported in Chapter 2 indicated) men frequently learn and perform job tasks by watching and talking with others. In such cases, listening is a more relevant language reception skill than reading. Hence a listening test was included in the battery of literacy tests. As mentioned earlier, we also included an arithmetic test in the literacy battery to assess ability in the use of a highly formal language system.

RESEARCH SUBJECTS

The subjects of this research worked in the three MOSs previously considered (Repairman, Supply Specialist, and Cook). In addition, men in a fourth MOS, Armor Crewman (MOS 11E), were studied. Men in all four of these MOSs were being studied under another HumRRO research program, Work Unit UTILITY,[2] and the REALISTIC I (see Figure 1) literacy measurement requirements were appended to that effort. In keeping with the design for Work Unit UTILITY, subjects for REALISTIC I were high (AFQT $>$ 30) and low (AFQT $<$ 30) aptitude men who were paired with regard to the amount of time they had worked on the job. However, for the purposes of REALISTIC,

[1] The psychometric and job proficiency data used in this chapter were obtained under HumRRO Work Unit UTILITY, to which study the literacy measures of REALISTIC were appended in the interests of efficiency of data collection. Our indebtedness to the UTILITY staff, and in particular to Dr. Robert Vineberg and Dr. Elaine Taylor, is gratefully acknowledged. Of course, responsibility for the data analyses and interpretations of this report rests with the authors.

[2] Detailed description of the UTILITY rationale, procedures, subjects and test materials is given in references 2, 6, and 7.

the only importance of this pairing procedure was that the lower aptitude men were over-represented in the sample. For this reason the figures presented for literacy skill levels should not be construed as parameters of the general Army population.

The four MOSs which were studied were selected on a variety of criteria:

(1) They represent a range of types of job skills.

(2) They are high density jobs to which a substantial portion of low aptitude men are assigned.

(3) Except for Armor Crewman, these Army jobs have close counterparts in the other services as well as in the civilian society.

The nature of these jobs is apparent: Cooks prepare food in accordance with a master menu and detailed recipes; Supply Specialists requsition and issue supplies and maintain records—primarily clerical tasks; Repairmen diagnose and repair motor vehicles; and the Armor Crewmen operate the tank and its weapons systems—a substantially procedural set of tasks.

These jobs differ widely in the number of job-related reading tasks involved in job performance, as well as in the literacy and arithmetic requirements for entry. For each, the training program contains a large amount of reading material and, for each, extensive manuals are available as part of the job equipment.

LITERACY AND OTHER PREDICTOR MEASURES

Reading—To assess reading skills, the Survey of Reading Achievement, Junior High Level (grades 7-9) developed by the California Test Bureau was used. This test was chosen because (a) it provides a composite index of reading skills expressed in school grade equivalents; (b) grade placement norms span a wide range of abilities (grades 4.0-14.5), a necessary characteristic when testing men whose AFQT scores range from the 10th to the 99th percentile; (c) it has a testing time of 40 minutes which could be accommodated within the Work Unit UTILITY testing schedule.

Arithmetic—Arithmetic skills were measured by use of the Survey of Arithmetic Achievement, Junior High Level, California Test Bureau, a companion test to the reading instrument and selected for the same reasons.

Listening—Listening skills were measured by a non-standardized experimental test constructed for this project. It consists of three short descriptive passages presented orally on tape. After each passage, 12 questions, calling for information contained in the passage, are read aloud twice, and after each question the subject is required to write his single word or short phrase answer. When the passages are regarded as reading material, they fall at the 6th, 7th, and 14th grade level of reading difficulty.

AFQT—The Armed Forces Qualification Test (AFQT) is a measure of trainability which is used as a "screening" measure for acceptance into all our armed services. It consists of 25 multiple-choice items in each of four areas: *Verbal*, vocabulary; *Arithmetic*, simple word problems; *Shop Mechanics*, matching line drawings of tools and mechanical equipment according to function; and *Pattern Analysis*, or form perception. Corrected for guessing, scores from the four sections are pooled and converted to percentile ranks. The Project 100,000, "New Standards" men, mentioned in Chapter 1, fall primarily in the 10 to 20 percentile range.

JOB PROFICIENCY MEASURES

The job proficiency measures were developed by the Work Unit UTILITY staff in conjunction with Army content experts. There were three different measures of job proficiency (see reference 7, for a more complete description of these measures).

Job Knowledge—The job knowledge measures were multiple choice tests (ranging from 75 to 96 items in length) for different job areas. These tests were made up of samples of knowledge considered by experienced job occupants to be important for competently fulfilling the job. The test items were selected for relevance to job performance, not to school training. Since these were paper-and-pencil tests, the need for reading skills was inherent in the task.

Job Sample—Job sample tests were constructed so as to represent the key tasks, in terms of essentiality, frequency, and urgency, typically performed by men in the jobs. For the most part they do not directly test reading skills, but they do represent what men *do* in these jobs. Also, the tests were not free of verbal demands since the instructions were presented orally. Hence the listening component of literacy was inherent in the testing situation, though not necessarily involved in the job task per se.

The tests were administered by trained testing crews, at special test sites, using full normal job equipment. Cooks cooked on field ranges; Supply Specialists worked in a fully equipped mock-up supply room; Repairmen repaired trucks and tanks; Armor Crewmen performed in tanks, simulating only the firing of weapons. In short, the job sample performance tests were hands-on samples of job tasks performed in a given career field.

Supervisor's Questionnaire—Each subject was rated by his immediate supervisor who had been instructed by the study staff that his ratings would be used for research purposes only and would have no administrative effect on the subject. Ratings were obtained on two rating scales: (a) the Standard Army Enlisted Evaluation Report, consisting of five- or six-point scale ratings on 14 attributes such as conduct, job performance, cooperativeness, reliability, job knowledge, and responsibility; and (b) an experimental scale on 12 items such as, "Does he need more supervision on the job than most?" and "If you could, would you just as soon replace him?" Since the two rating scales correlated .80, scores of the two scales were summed to increase the reliability of the supervisory rating measure of job proficiency in this study.

RESEARCH FINDINGS

The ultimate objective of the data analysis is to determine how well performance on one or more of the predictor variables predicts performance on the various job proficiency measures. First, however, it is informative to note how performance on the literacy tests and AFQT was distributed in the groups of men studied in the four jobs.

Table 7 shows number and percentage of men at various levels on the three literacy tests and the AFQT. These figures are for the four MOSs combined. It is interesting to note that, although half the total sample was from AFQT Mental Category IV, less than 10% of the population read below the 6.0 grade level, and fewer than 18% performed below the 6.0 grade level in arithmetic. Also, although 25% of the persons in our sample had AFQT scores in the 1-20 range, only 2% of the subjects read below the 4.9 grade level. This contrasts with Department of Defense data (1) which indicated that, out of 46,000 "new standards" men (primarily men with AFQTs in the 10-20 range) tested at the Armed Forces Entrance Examination Centers, some 31% read below the 4.9 level.

Using 31% as the expected proportion of men to be found in the 10-20 AFQT and who have reading scores below 4.9, we would expect 123 of our sample of 398 men with AFQT scores of 10-20, to score below 4.9. Instead, as Table 7 indicates, only 31 men out of 1564, including 398 lower Category IV men, read in the 4.9 or below ranges. Apparently, the very low reading, lower mental Category IV men do not well survive the additional screening imposed by BCT, AIT, and early job experience. Since these very low readers are, in large part, missing from our sample, relationships between literacy

Table 7

Distribution of Subjects by Literacy and AFQT Level

(Percent)

Reading			Arithmetic			Listening			AFQT		
Score[a]	*N*	%	Score[a]	*N*	%	Score	*N*	%	Score	*N*	%
4–4.9	31	2.0	4–4.9	38	2.4	1–4	22	1.4	1–10	24	1.5
5–5.9	108	6.9	5–5.9	238	15.2	5–8	51	3.3	11–20	374	23.9
6–6.9	228	14.6	6–6.9	295	18.9	9–12	146	9.3	21–30	384	24.6
7–7.9	328	21.0	7–7.9	424	27.1	13–16	308	19.7	31–40	190	12.1
8–8.9	233	14.9	8–8.9	184	11.8	17–20	381	24.3	41–50	139	8.9
9–9.9	273	17.5	9–9.9	142	9.1	21–24	353	22.6	51–60	141	9.0
10–10.9	168	10.7	10–10.9	74	4.7	25–28	230	14.7	61–70	131	8.4
11–11.9	55	3.5	11–11.9	52	3.3	29–32	73	4.7	71–80	75	4.8
12–12.9	83	5.3	12–12.9	37	2.4	33–36	0	0	81–90	73	4.7
13 & up	57	3.6	13 & up	80	5.1				91–100	33	2.1
Total	1564			1564			1564			1564	

[a]Score=School Grade Equivalent.

variables and job proficiency should be viewed as attenuated and, in general, as underestimates of the true relationships between literacy and job proficiency.

Differences among the four MOSs in performance on the literacy tests are presented in Table 8. This table shows the percentage of men in each MOS who scored below the grade 7.0 level on the reading and arithmetic tests, and below a raw score of 13 on the experimental listening test. With regard to reading, the percentage of men reading below the grade 7.0 level in the Supply Specialist MOS is less than one-half that of the Cook where fully one-third read below the 7.0 level. The Repairman and Armor Crewman jobs occupy a midpoint between Supply Specialist and Cook.

It is interesting to recall from earlier portions of this report that the reading materials in the Supply Specialist MOS are most difficult, and the Cook the least difficult, with the Repairman in between. If men were being assigned to these three jobs on the basis of the reading difficulty of the materials, the assignment would reflect the reading achievement distributions in Table 8. That is, since Supply Specialist has the most difficult reading materials, it would not be desirable to assign many of the poorer reading men to that career field. However, since the Cook reading materials are much easier, men

Table 8

Men Scoring Below Grade Seven on the Reading and Arithmetic Tests and Below Score Thirteen on the Listening Test

Literacy Test	Military Occupational Specialties							
	Supply Specialist		Armor Crewman		Repairman		Cook	
	N	Percent	*N*	Percent	*N*	Percent	*N*	Percent
Reading	65	16.1	81	21.0	94	23.7	127	33.3
Arithmetic	118	29.4	156	40.6	146	36.9	151	39.6
Listening	42	10.4	41	10.7	20	5.1	116	30.3

of lower reading abilities could be assigned to that job. Possibly then, the classification of men into these career fields would take into account, at a judgmental level, the reading demands of the job.

A further index of the differences among the MOSs is the performance on the listening test. Approximately one-third of the Cooks scored 12 or below on this test, as compared to 5 to 10% of the men in the remaining jobs. Differences in terms of arithmetic performance are not pronounced, although Supply Specialist again showed the fewest men in the lower skill range. The data of Table 8 suggest that the literacy demands may be greatest for Supply Specialist, about equal for Armor Crewman and Repairman, and least for Cook. This is consistent with the findings reported earlier in this chapter.

INTERRELATIONSHIPS AMONG LITERACY MEASURES

Table 9 presents an intercorrelation matrix for literacy variables, selected personal background variables, and the AFQT. The data in Table 9 shows that reading, arithmetic, and AFQT—all tests requiring reading ability—are substantially intercorrelated. This is not surprising since one-quarter of the AFQT is vocabulary and one-quarter arithmetic word problems. These three tests show similar profiles over the other predictors. Listening, a verbal but non-reading test, presents a somewhat attenuated version of this pattern.

With regard to literacy and personal background factors, Table 9 shows positive relationships of reading and arithmetic to education in our sample. Age is not correlated to any extent with any of the other variables, while the negative coefficients for race with the various measures of cognitive skills suggest that English-speaking Caucasians score somewhat higher on these language-oriented measures than non-Caucasians or Caucasians from homes where standard English may not be the predominant language.

The relationship indicated by the correlation between AFQT and reading grade in Table 9 is depicted graphically in Figure 7. The height of the solid line at any point represents the average reading grade level for men at the AFQT level indicated on the baseline. The dotted lines are drawn one standard deviation (1.6 grade units, on the average) above and below the mean score and constitute a band within which two-thirds of the scores would be expected to fall. Thus for men with AFQT of 35, the average

Table 9

Intercorrelations of Predictor and Selected Background Variables Summed for Four Army Jobs

Variables	Variables						
	1	2	3	4	5	6	7
1. Reading	–	.69	.65	.54	.30	−.04	−.27
2. Arithmetic	.69	–	.61	.43	.34	−.10	−.22
3. AFQT	.65	.61	–	.47	.26	.01	−.30
4. Listening	.54	.43	.47	–	.12	.00	−.22
5. Education	.30	.34	.26	.12	–	.01	.12
6. Age	−.04	−.10	.01	.00	.01	–	.11
7. Race[a]	−.27	−.22	−.30	−.22	.12	.11	–

[a]For computing the correlations with race, Caucasian was assigned the code number of 0, and Negro the code number of 1.

Relationship Between AFQT and Reading

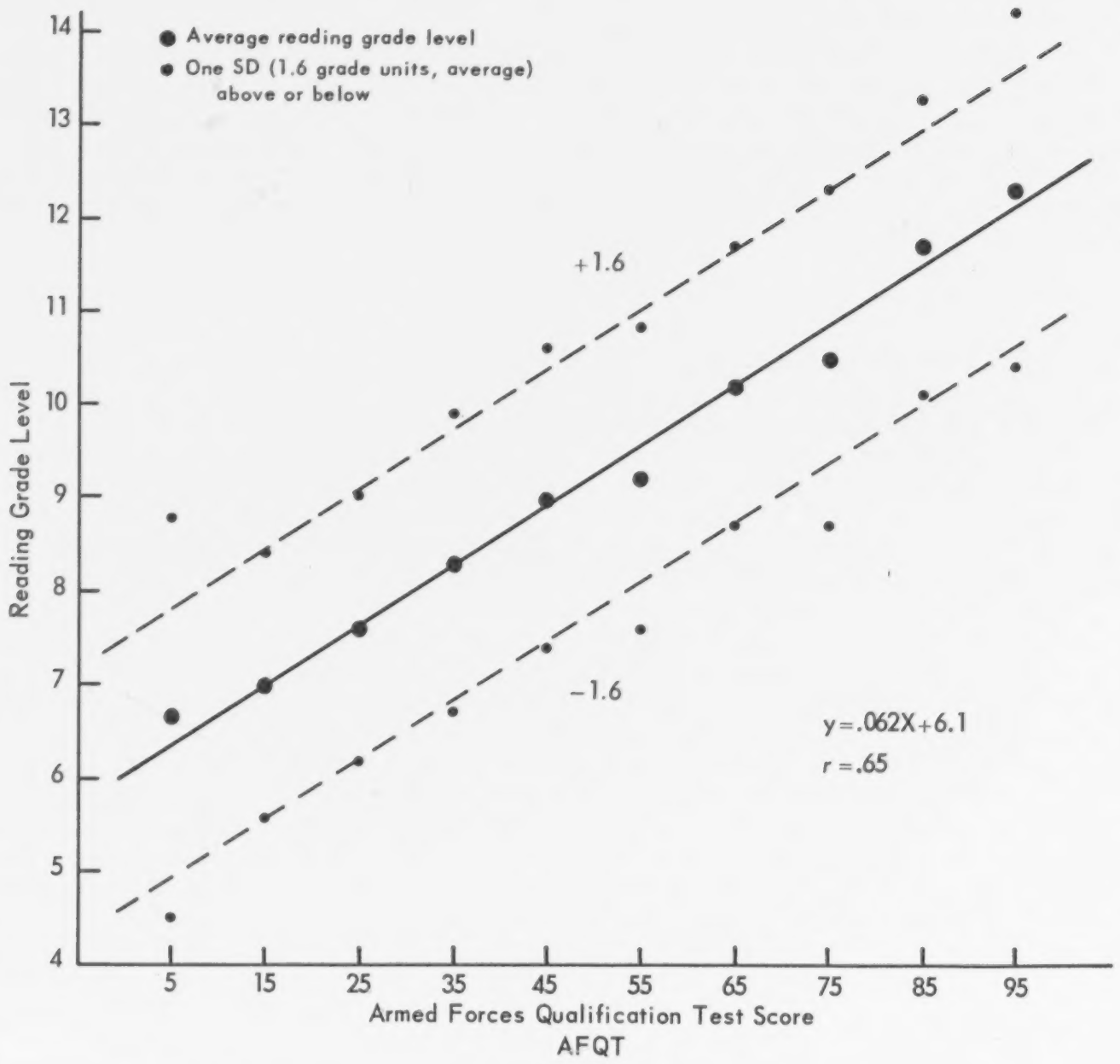


Figure 7

reading grade level was about 8.3. It would be expected that two-thirds of the men with that AFQT would read between the 6.7th and 9.9th grade level; of the remainder, one-sixth would read below, and one-sixth above these points.

INTERRELATIONSHIPS AMONG JOB PROFICIENCY MEASURES

A second group of variables of interest is the job proficiency measures, the job knowledge and job sample test scores and the supervisor ratings. The interrelationships of these variables determine to what extent these measures describe a man's job proficiency in a similar fashion. If tests agree in describing proficiency, men who score high on the job knowledge test would be expected to score high on the job sample test and supervisor rating. Thus, high correlation coefficients indicate that men are being ranked about the same from one index of proficiency to another. Low coefficients indicate that

tests are ranking men in a different manner, with perhaps little agreement from test to test. This may be evidence that the criterion measures are sampling different aspects of job proficiency.

Before the interrelationships among the measures of job proficiency are considered, it should be pointed out that, because of the wide range of job proficiency of men in the Work Unit UTILITY sample, and the high correlation of job proficiency to time on the job, the proficiency scores have been adjusted statistically, using regression-based scores estimated from the logarithm of time on the job, to remove the effects of job experience. Hence all of the relationships we discuss are freed of the influence of time on the job (Appendix B).

Table 10 presents the interrelationships among the adjusted proficiency measures. As indicated, the relationships are consistent from one MOS to the next. The coefficients between job knowledge and job sample are higher than those for either knowledge or job sample with the supervisor ratings. This suggests that the knowledge and sample tests are sampling more of a common aspect of proficiency than the aspect of proficiency reflected by the supervisor rating. The fairly large (.64) coefficient for the supply field between knowledge and job sample reflects the commonality of the paper-and-pencil aspects of the man's job performance and the paper-and-pencil aspects of the job knowledge test. Overall then, for all MOSs, the job knowledge and job sample performance tests appear to be sampling some similar aspects of job proficiency, while the supervisor rating is largely an independent estimate of job proficiency.

Table 10

Intercorrelations Among Adjusted Proficiency Measures[a]

Adjusted Proficiency Measures	Military Occupational Specialties			
	Armor Crewman	Repairman	Supply Specialist	Cook
Knowledge/Performance	.50	.50	.64	.50
Knowledge/Supervisor Rating	.21	.18	.29	.27
Performance/Supervisor Rating	.13	.16	.24	.20

[a] See Appendix B.

INTERRELATIONSHIPS BETWEEN PREDICTOR AND CRITERION VARIABLES

The intercorrelations of predictor and criterion variables, with the latter statistically adjusted to be freed of the effects of time on the job are listed in Table 11. The supervisor ratings are not related to any of the predictor variables to any meaningful degree.[1] Hence, the prediction of job proficiency when measured by the supervisor rating is not feasible with any of these predictor variables and will not be treated further in this report.

[1] See HumRRO Technical Report 71-1 (2, p. 5) for further discussion.

Table 11

Correlations Between Predictors and Job Proficiency Measures

MOS	Predictor	Job Proficiency Index		
		Job Knowledge	Job Performance	Supervisor Ratings
Armor Crewman	AFQT	.55	.37	.07
	Reading	.57	.32	.06
	Arithmetic	.49	.31	.14
	Listening	.53	.29	.06
Repairman	AFQT	.44	.32	.16
	Reading	.47	.26	.17
	Arithmetic	.39	.24	.14
	Listening	.40	.38	.09
Supply Specialist	AFQT	.36	.37	.09
	Reading	.40	.40	.10
	Arithmetic	.34	.36	.09
	Listening	.35	.42	.11
Cook	AFQT	.49	.37	.15
	Reading	.56	.34	.11
	Arithmetic	.44	.31	.13
	Listening	.39	.28	.07

The data for job knowledge scores indicate that, across all four MOSs, job knowledge is most closely related to reading and AFQT, and less closely related to arithmetic and listening (with the exception of the Supply Specialist MOS). For job sample performance, however, all of the literacy variables and the AFQT are lower in predictive precision. Thus, the data indicate that the literacy variables predict job measures, which place a heavy demand on reading, better than they predict job sample data, which demand little direct application of reading although general language demands persist.

The correlation coefficients indicate the overall relationships among the predictor and criterion variables. Perhaps a more meaningful and useful indication of the relevance of reading skills for job proficiency may be obtained by considering Figures 8, 9, 10, and 11. These figures were constructed for each reading level by determining the percentage of men in *that* reading level who scored among the bottom 25% (fourth quarter), next-to-the bottom 25% (third quarter), next-to-the top 25% (second quarter), and top 25% (first quarter) of all those men who took the tests. Thus, each of the bars shows the proportion of men at that reading level who scored in each of the four quarters of job proficiency. The sum of the proportions in each bar is 100%, which accounts for all of the men at a given reading level.

In each figure, the bar at the bottom indicates the proportion of men that would be expected in each quarter (25%) if the correlation of job proficiency and reading was 0. Over-representation in any quarter is indicated by a score greater than 25%, while under-representation is indicated by a score less than 25%. Under- or over-representation, especially in the bottom and top quarters, is expected when the literacy-job proficiency correlation is greater than zero. In Figures 8, 9, 10, and 11, the numbers within each division show the proportion of persons at that reading level who are in the designated quarter.

Quarter Distributions of Job Knowledge and Performance by Reading Grade Level: Armor Crewman *(MOS 11E)*

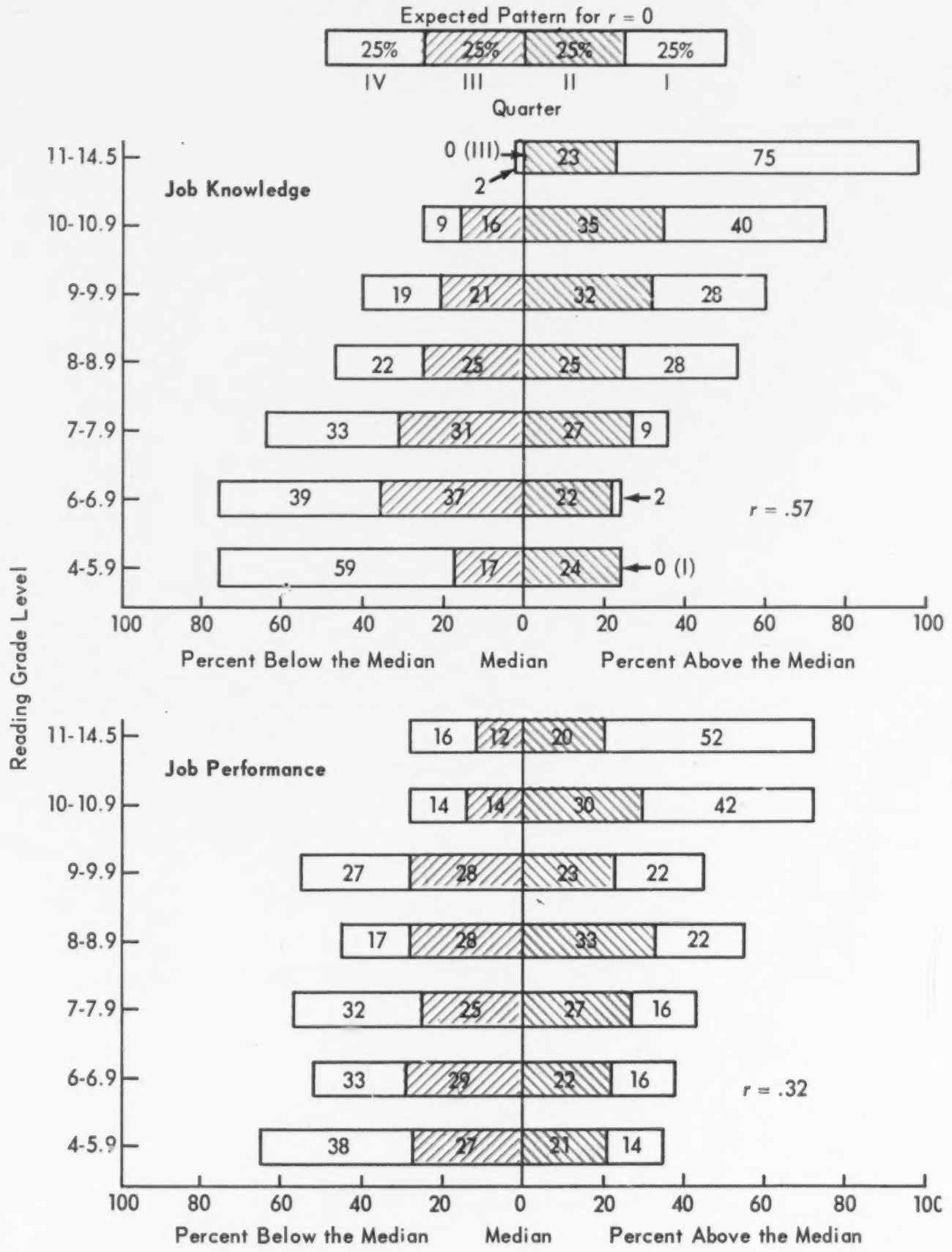


Figure 8

Quarter Distributions of Job Knowledge and Performance by Reading Grade Level: Supply Specialist *(MOS 76Y)*

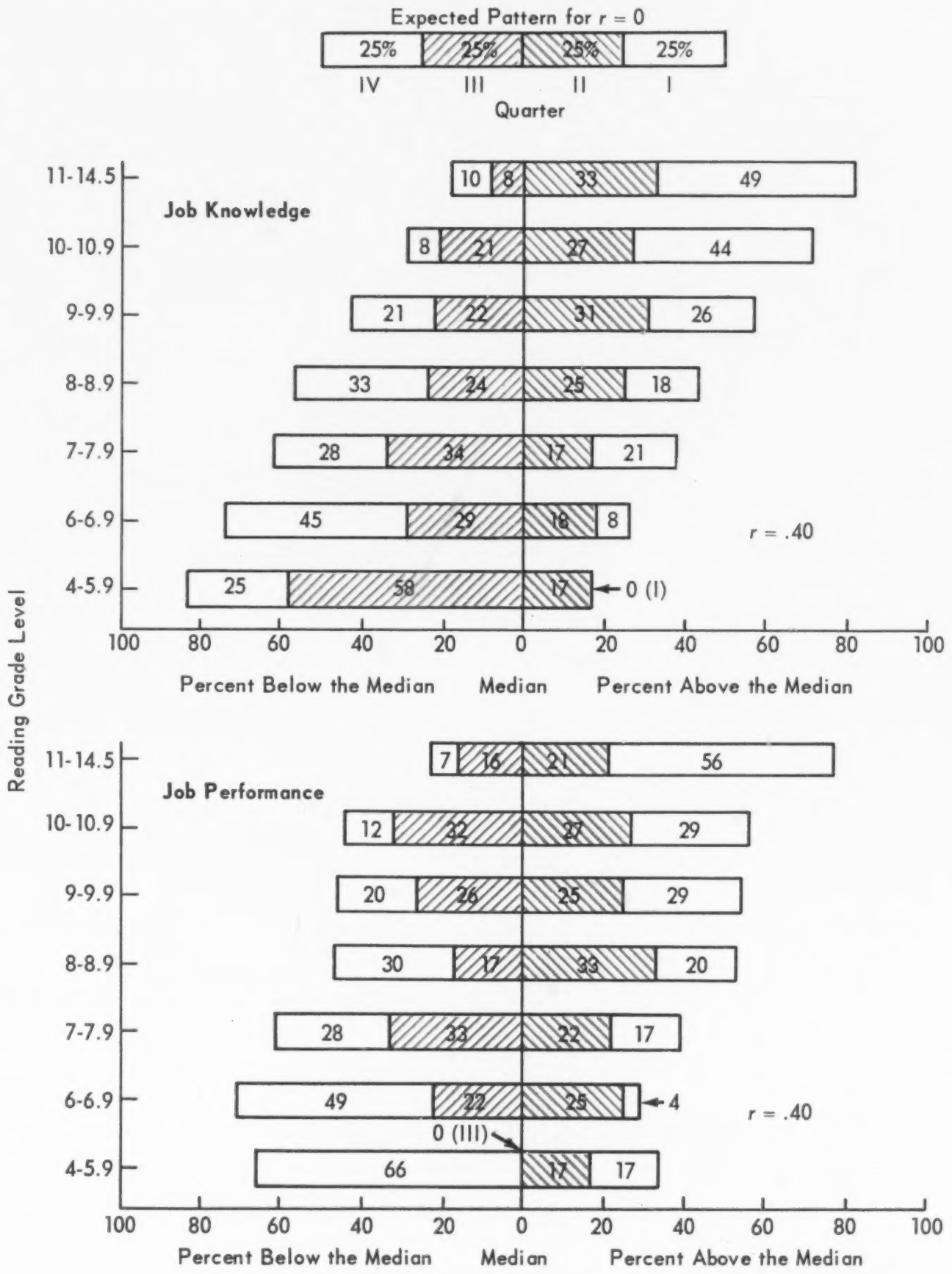


Figure 9

Quarter Distributions of Job Knowledge and Performance by Reading Grade Level: Repairman *(MOS 63C)*

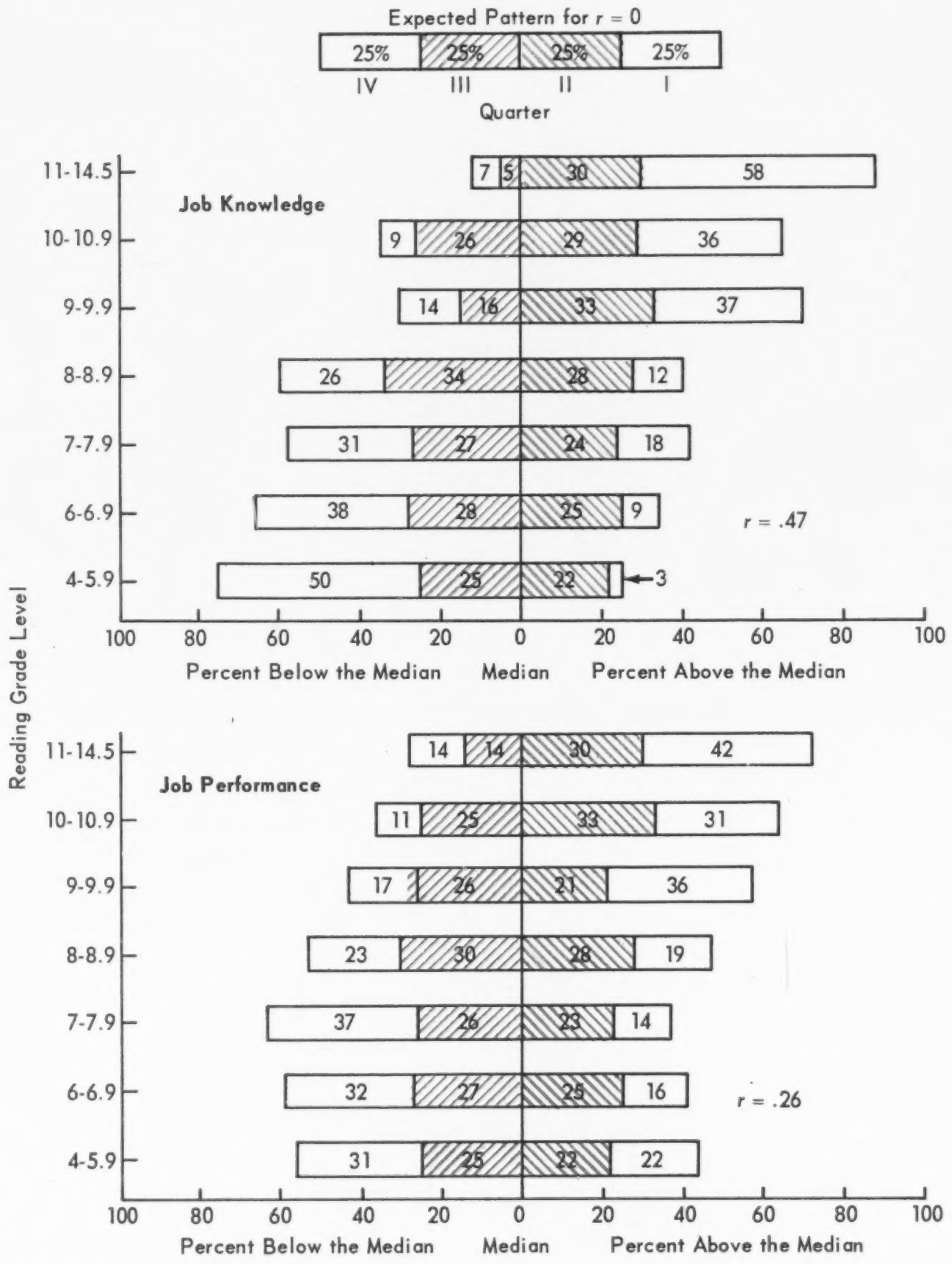


Figure 10

Quarter Distributions of Job Knowledge and Performance by Reading Grade Level: Cook *(MOS 94B)*

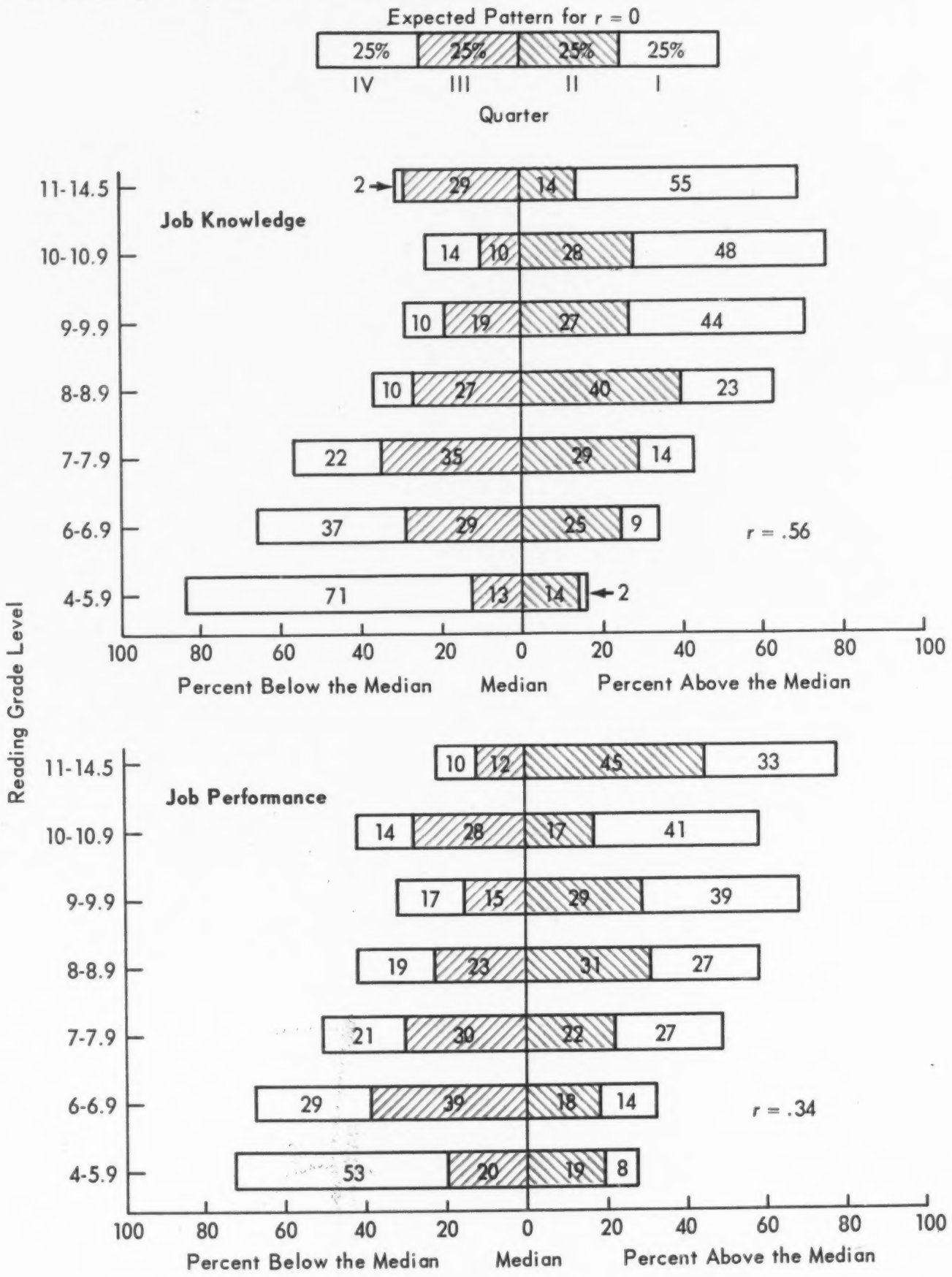


Figure 11

Figure 8 which deals with job knowledge and performance for Armor Crewmen shows that 98% of the men who read at the 11-14.5 level scored above the median on the knowledge test. Furthermore, 75% were among the best (top quarter) of those who took the job knowledge test. Looking at the lowest reading level, the figure shows that only 24% of men in the 4-5.9 reading level scored above the median on the job knowledge test. None was in the first quarter. On the other hand, 59% of the poorest readers performed at the level of the bottom 25% of their fellow job incumbents who took the knowledge test.

Referring to these figures, the probabilities associated with placement in the fourth, third, second, or first quarter on the two proficiency tests can be determined as a function of reading ability. For instance, in Supply, the probability is .66 (66 times out of a hundred) that the score of a man who reads in the 4-5.9 level will fall in the bottom quarter of job proficiency when measured by the job sample performance test. These probabilities are, respectively, .38, .31 and .53 in reference to job sample performance for the Armor Crewman, Repairman, and Cook. The probabilities in job knowledge are: Armor, .59; Repairman, .50; and Cook, .71.

READING REQUIREMENTS FOR FOUR MOS

In principle, all of the men tested in REALISTIC I were successful job performers by virtue of the fact that they were actively serving in a job position at the time of testing. This is somewhat analogous to saying that persons who hold a high school diploma can, by definition, read at the 12th grade level. In actuality, however, a student's reading level is defined in terms of his reading test performance *relative* to other people in the other school grades.

In a similar fashion, we can describe *adequate* job proficiency in terms of the relative proficiency of job incumbents. Thus, the data of Figures 8, 9, 10, and 11 show relative job proficiency for men at each reading level. That is to say, the men in the bottom quarter are there because their proficiency was poorer than three-fourths of the other men.

We find, however, that because of the significant correlations of reading and job proficiency, the different reading levels are disproportionately represented in the four quarters, especially in the top and bottom quarters. As the bar at the bottom of the figures indicates, if there were no correlations of reading and job proficiency, we would expect to find 25% of the people at each reading level in the bottom quarter, 25% in the third quarter, and so forth. This suggests a decision rule for determining the reading level to be specified for each job. The rule is to select the lowest reading level for which representation in the bottom quarter does not exceed 25%, that is, the level of representation that would occur if reading ability did not count (r=0).

Applying the above rule to the data for Armor Crewman (Figure 8) we find that, for job knowledge, 33% of the people who read at the 7-7.9 level are in the bottom quarter, while only 22% of those who read at the 8-8.9 level are in the bottom quarter. Thus, a reading level of approximately 8.0 grade is indicated as a targeted reading level for the Armor MOS when job knowledge is the criterion. Examination of the job sample data tends to confirm this level. There we find that 32% of the people reading at the 7-7.9 grade level are among the bottom job performers, while only 17% of the readers at the 8-8.9 grade level are in the bottom quarter. Again, then, an 8.0 grade level of reading appears to prevent over-representation in the bottom quarter.

Similar analyses (with some latitude for anomalies) applied to the job knowledge and job sample data for the Supply Specialist, Repairman, and Cook MOSs (Figures 9, 10, 11) suggest reading levels of 9.0, 8.0, and 7.0, respectively. It should be noted that

these levels rank the jobs in the same order as the reading task test criterion (Figure 6). That is, Supply Specialist is most demanding of reading skills, the Repairman is next, and the Cook is least demanding. Furthermore, this is consistent with the data of Table 8 which shows 16% of the Supply personnel scoring at the 7.0 reading level or below, while 23% of the Repairmen and 33% of the Cooks scored at or below the 7.0 grade level. This suggests that classification and/or attrition due to job demands has acted to restrict the number of poorer reading men in the Supply and Repairman MOSs.

When similar analyses are performed for the arithmetic (Figures 12, 13, 14, 15) and listening data (Figures 16, 17, 18, 19), the indicated level of arithmetic skills for Repairmen, Supply Specialists and Cooks is 7.0-7.9, while for Armor Crewmen a 6.0-6.9 level appears to suffice. For listening, scores in the 16-18 range appear sufficient to prevent disproportionate representation in the lowest quarter of job proficiency for both Armor Crewmen and Cooks. For Repairmen and Supply Specialists, scores in the 19-21 category appear to be associated with "adequate" job proficiency, as defined by representation in the lowest fourth of job incumbents. The increased demand for listening skill in the Supply Specialist and Repairman jobs, in contrast to that for the Cook, is consistent with the differences in reading requirements for these jobs. This suggests a greater need for general language skills in the Supply Specialist and Repairman fields.

Because of the substantial relationship between literacy measures and AFQT and because of the general importance and familiarity of AFQT, parallel analyses of the relationship between AFQT, job knowledge, and job sample performance for the four MOSs are presented in Figures 20, 21, 22, and 23. Application of the same decision rule used to establish the minimum literacy requirements for these four jobs would indicate an AFQT level not much less than 30 to insure against overrepresentation in the bottom quartile of job knowledge in each of these four MOSs.

Interestingly, as shown in Figure 7, an AFQT of 30 corresponds in these data to a reading grade level of 8.0, which is coming to be regarded as the defining level of functional literacy. The same AFQT requirement of 30 seems to be indicated for Job Sample performance in the case of Repairman, Supply Specialist, and Cook, while an AFQT of 20 appears sufficient to meet the job sample requirements for Armor Crewman.

Quarter Distributions of Job Knowledge and Performance by Arithmetic Grade Level: Armor Crewman *(MOS 11E)*

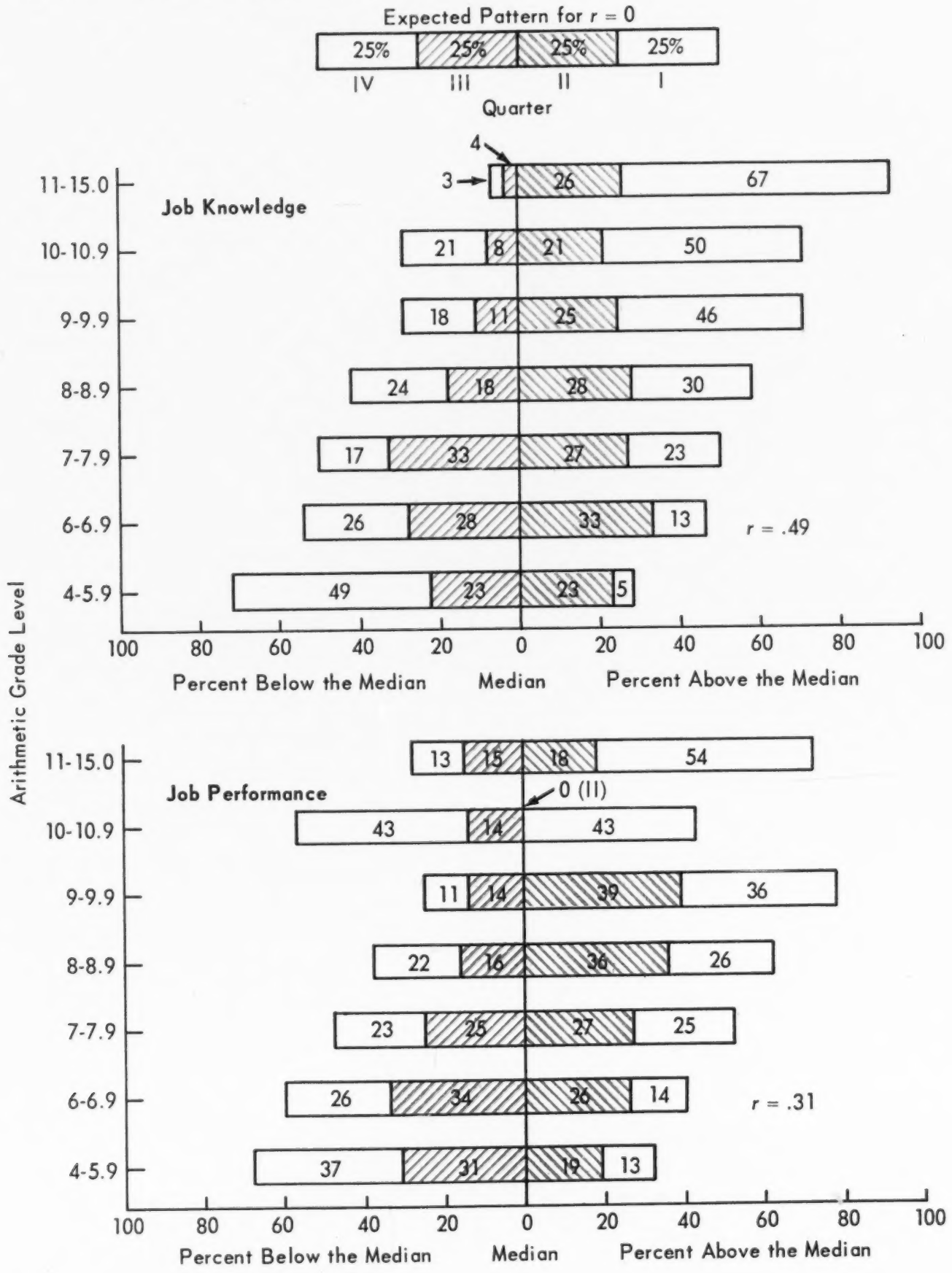


Figure 12

Quarter Distributions of Job Knowledge and Performance by Arithmetic Grade Level: Supply Specialist *(MOS 76Y)*

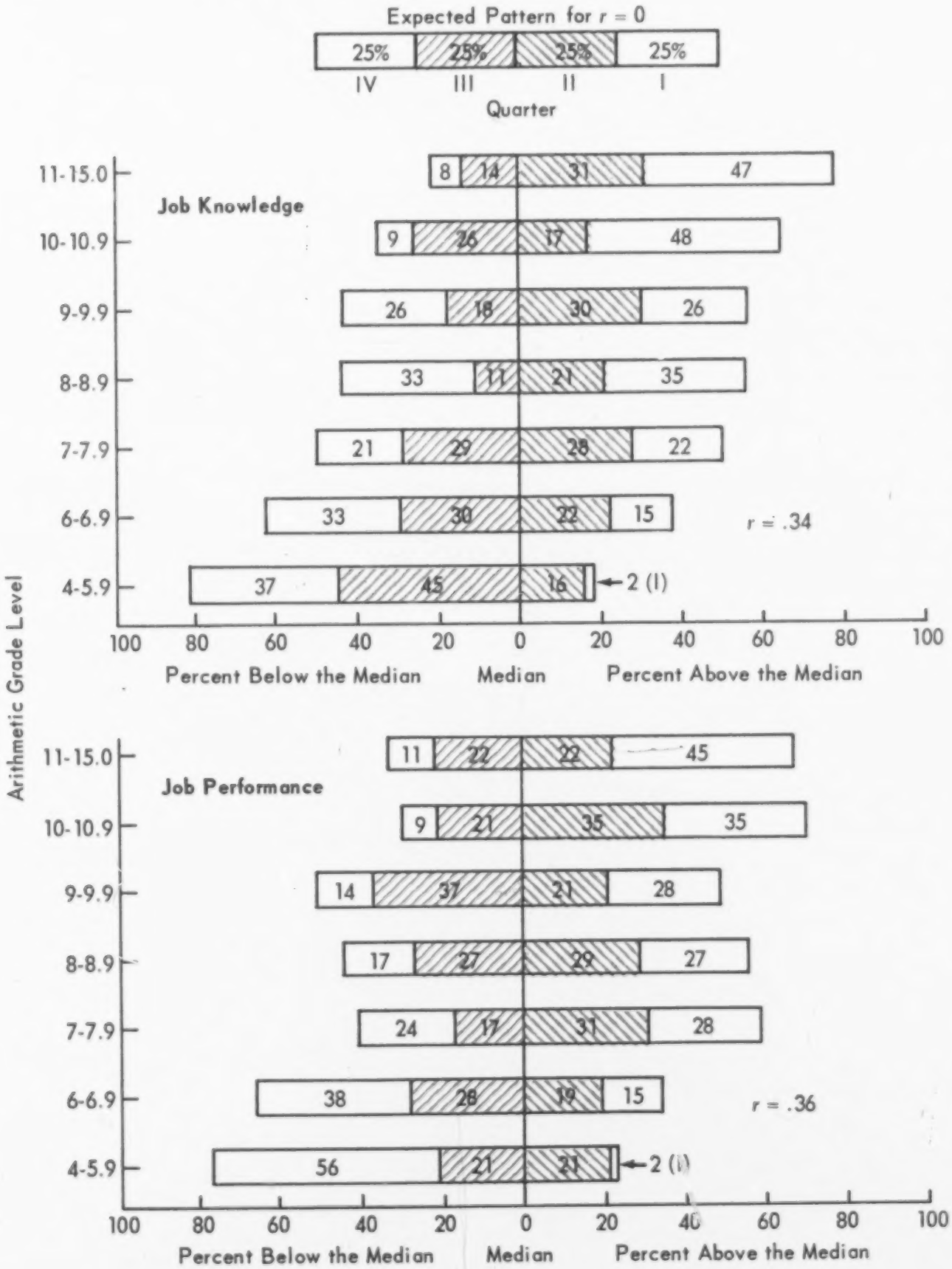


Figure 13

Quarter Distributions of Job Knowledge and Performance by Arithmetic Grade Level: Repairman *(MOS 63C)*

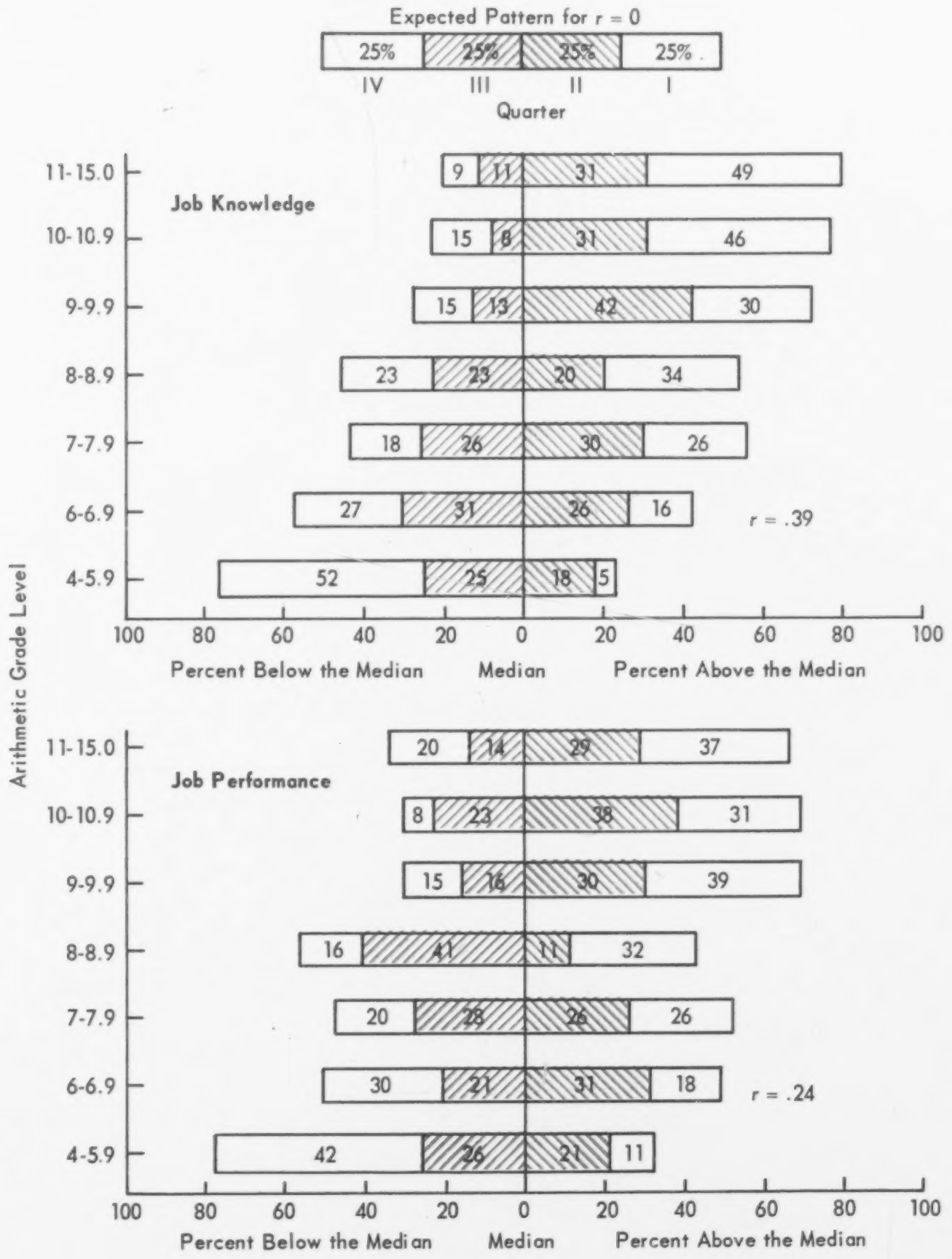


Figure 14

Quarter Distributions of Job Knowledge and Performance by Arithmetic Grade Level: Cook *(MOS 94B)*

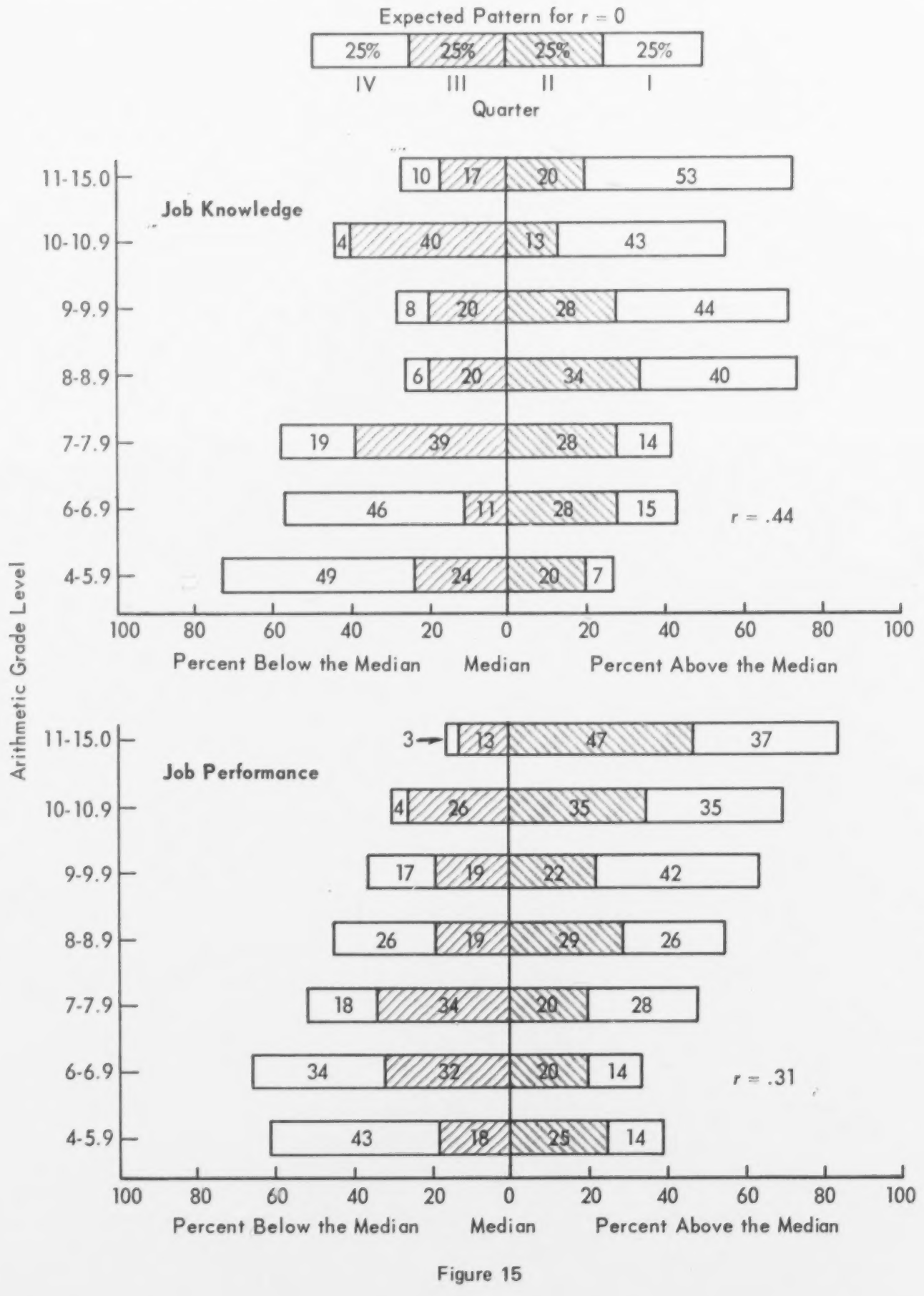


Figure 15

Quarter Distributions of Job Knowledge and Performance by Listening Score Level: Armor Crewman *(MOS 11E)*

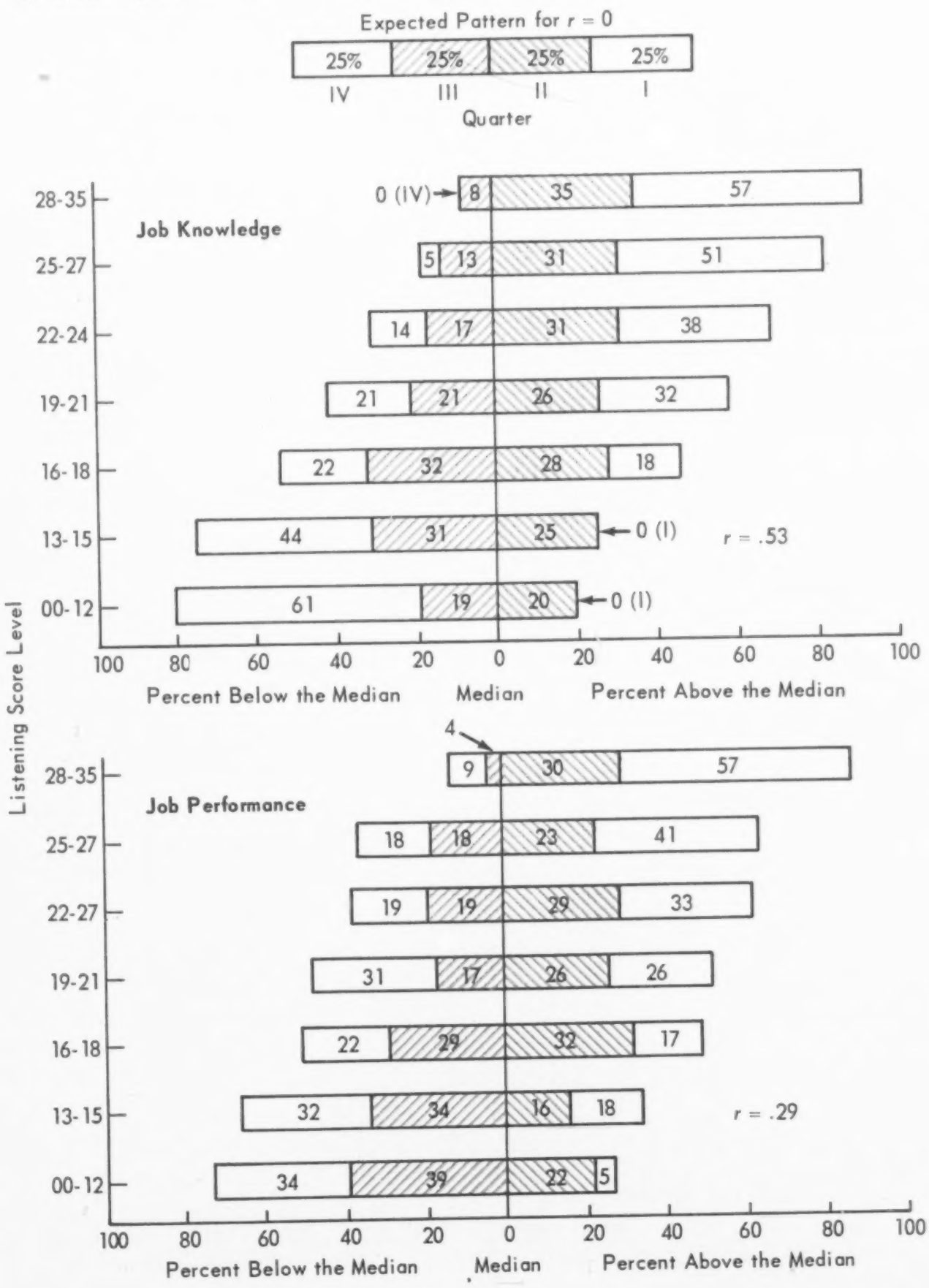


Figure 16

Quarter Distributions of Job Knowledge and Performance by Listening Score Level: Supply Specialist *(MOS 76Y)*

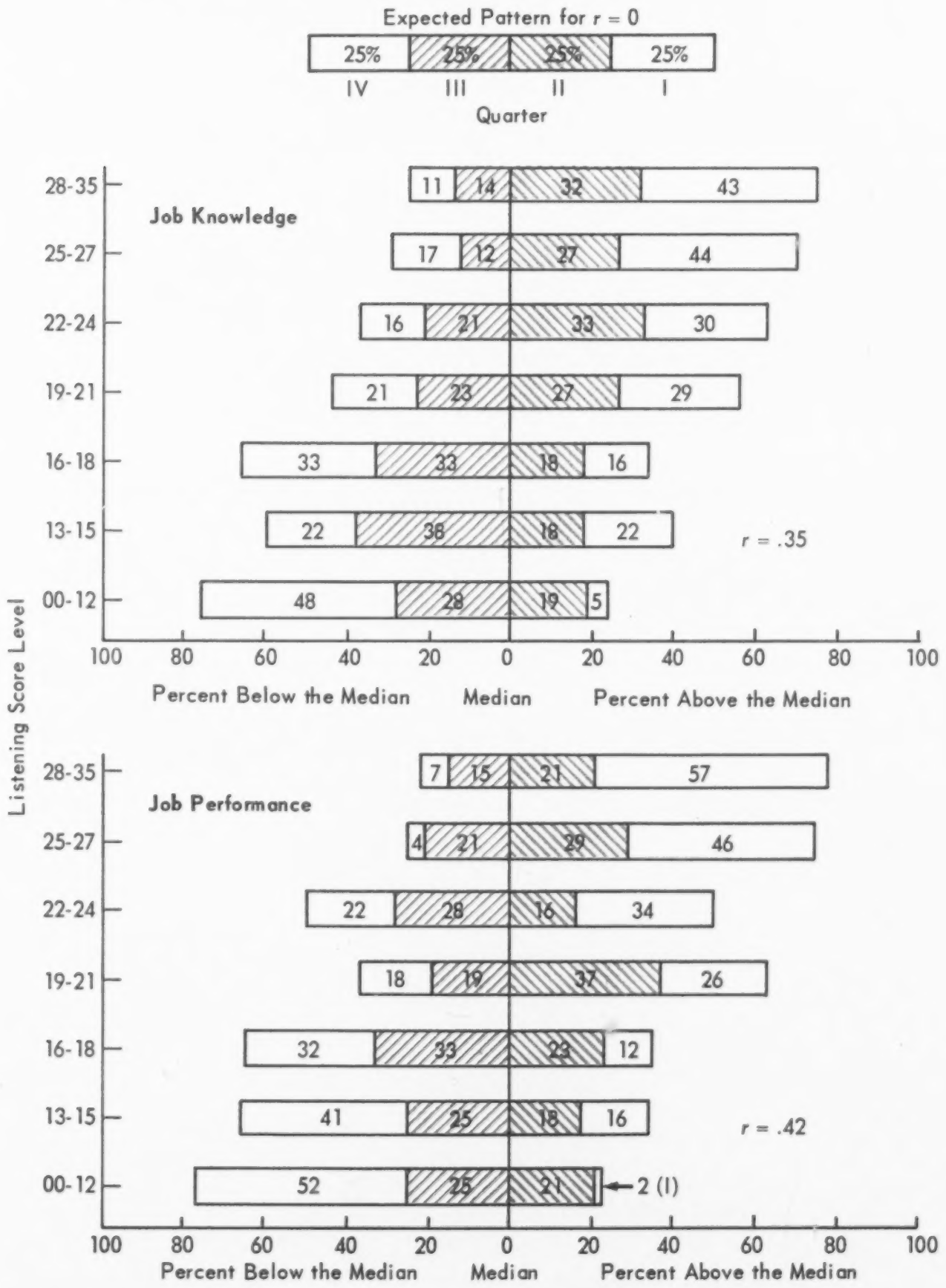


Figure 17

Quarter Distributions of Job Knowledge and Performance by Listening Score Level: Repairman *(MOS 63C)*

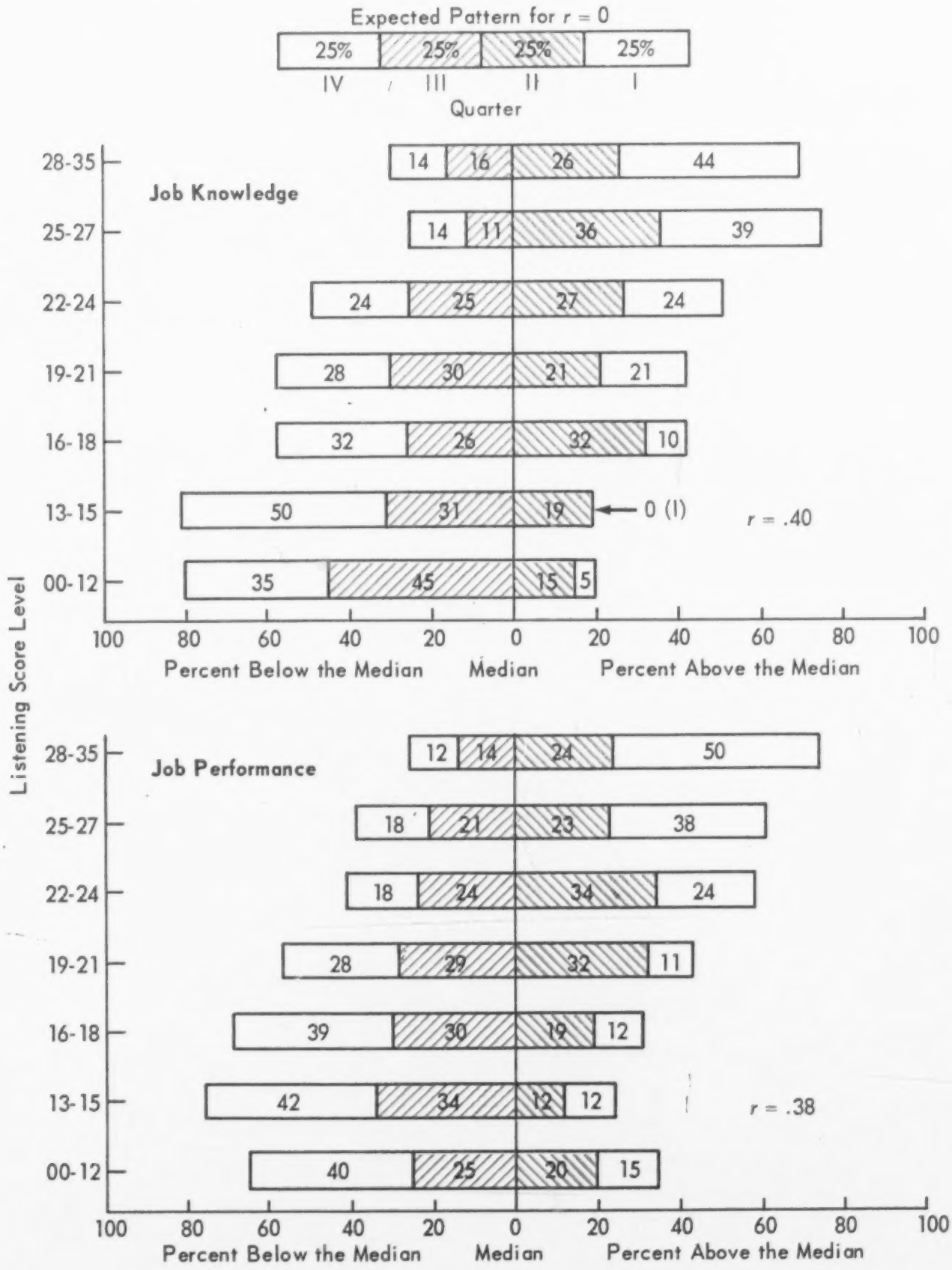


Figure 18

Quarter Distributions of Job Knowledge and Performance by Listening Score Level: Cook *(MOS 94B)*

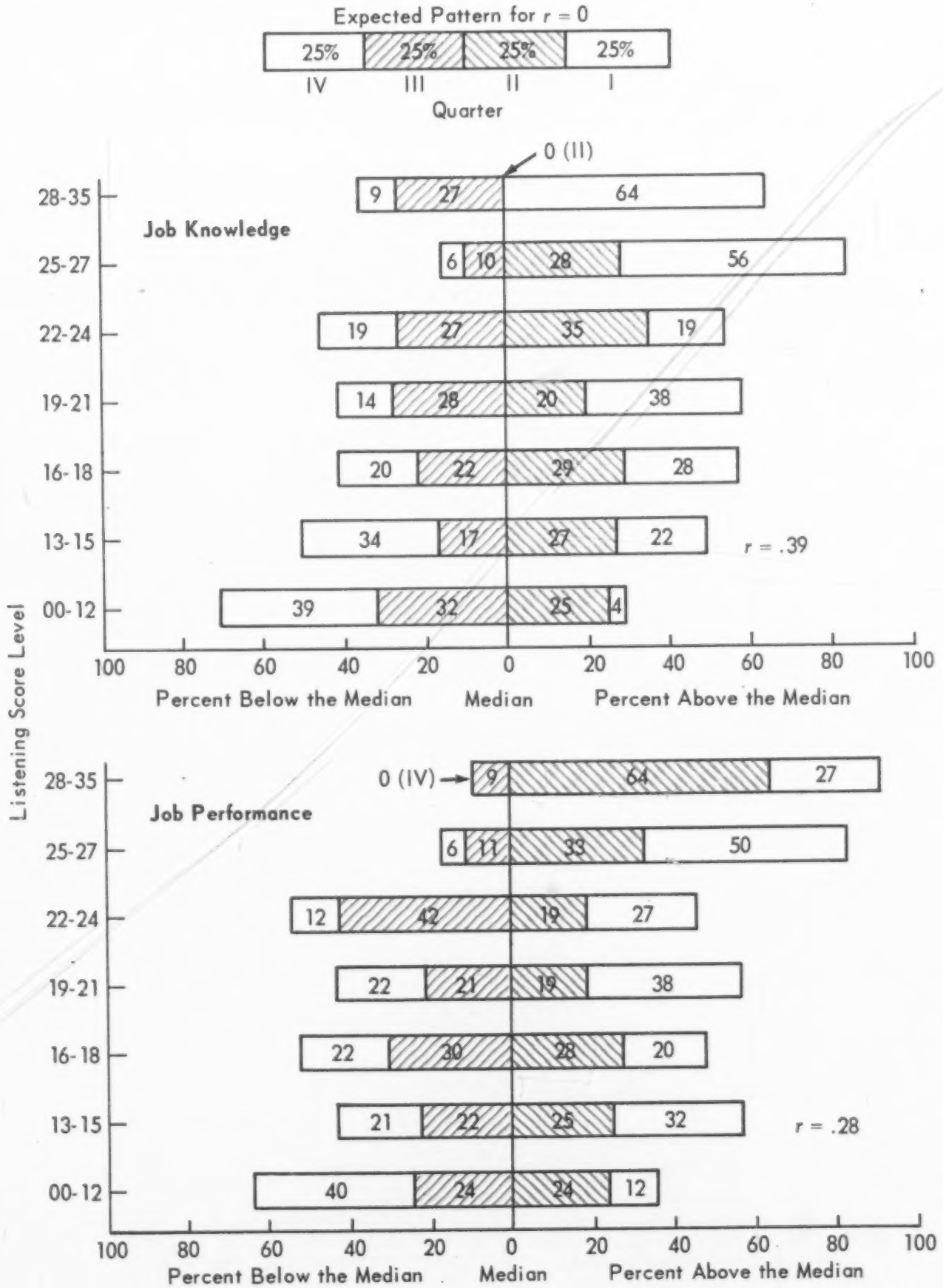


Figure 19

Quarter Distributions of Job Knowledge and Performance by AFQT Level: Armor Crewman *(MOS 11E)*

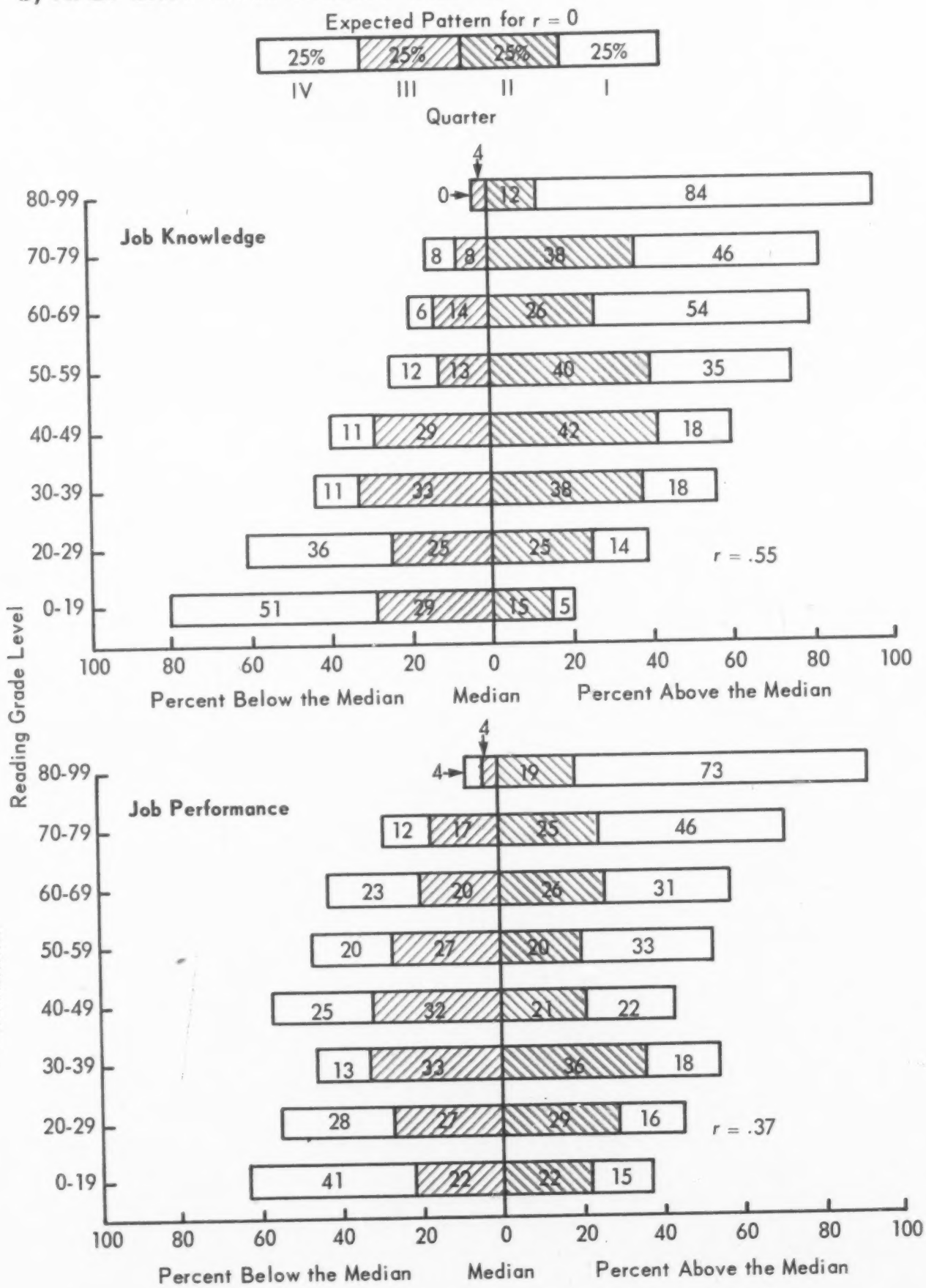


Figure 20

Quarter Distributions of Job Knowledge and Performance by AFQT Level: Supply Specialist *(MOS 76Y)*

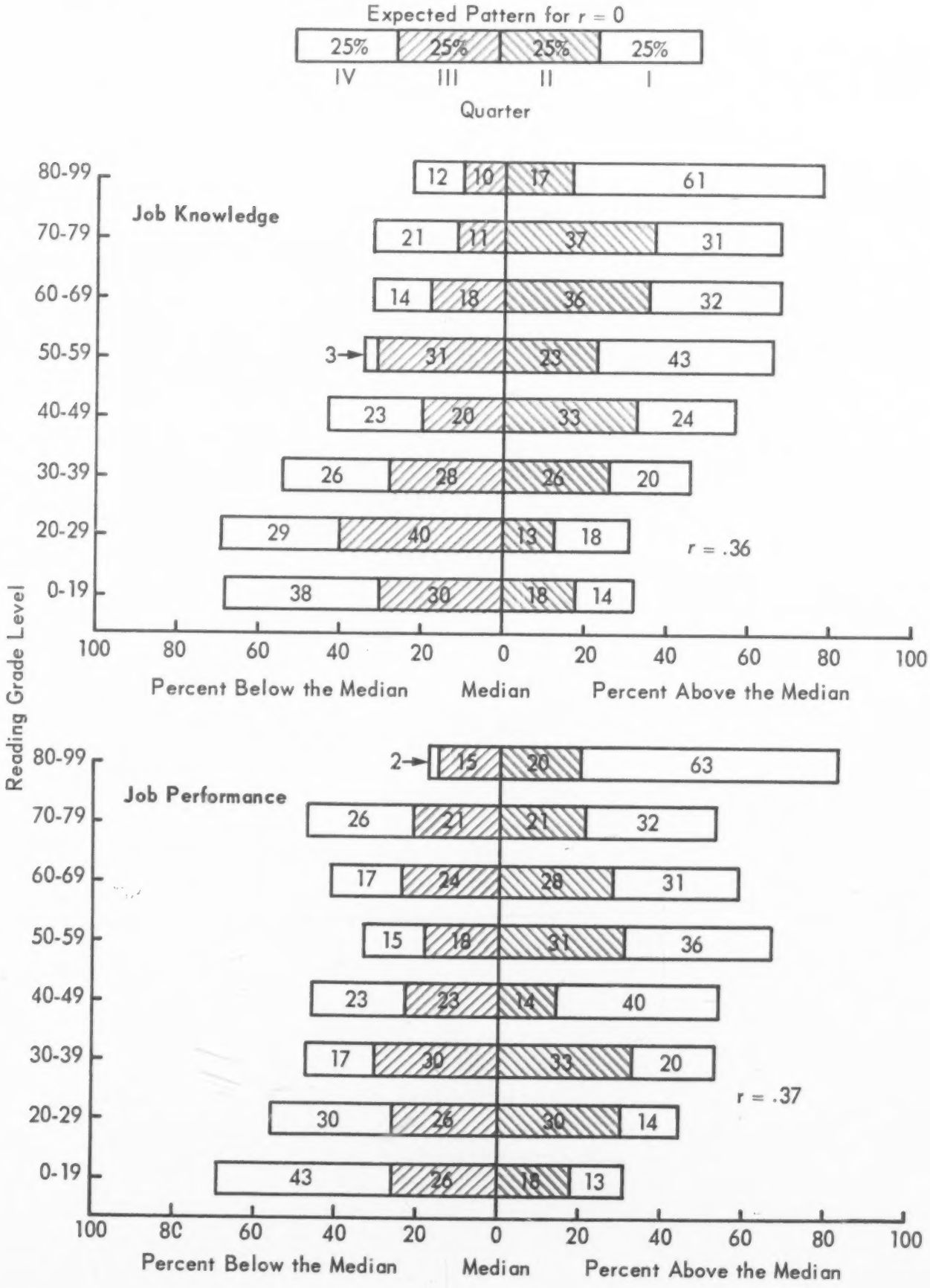


Figure 21

Quarter Distributions of Job Knowledge and Performance by AFQT Level: Repairman *(MOS 63C)*

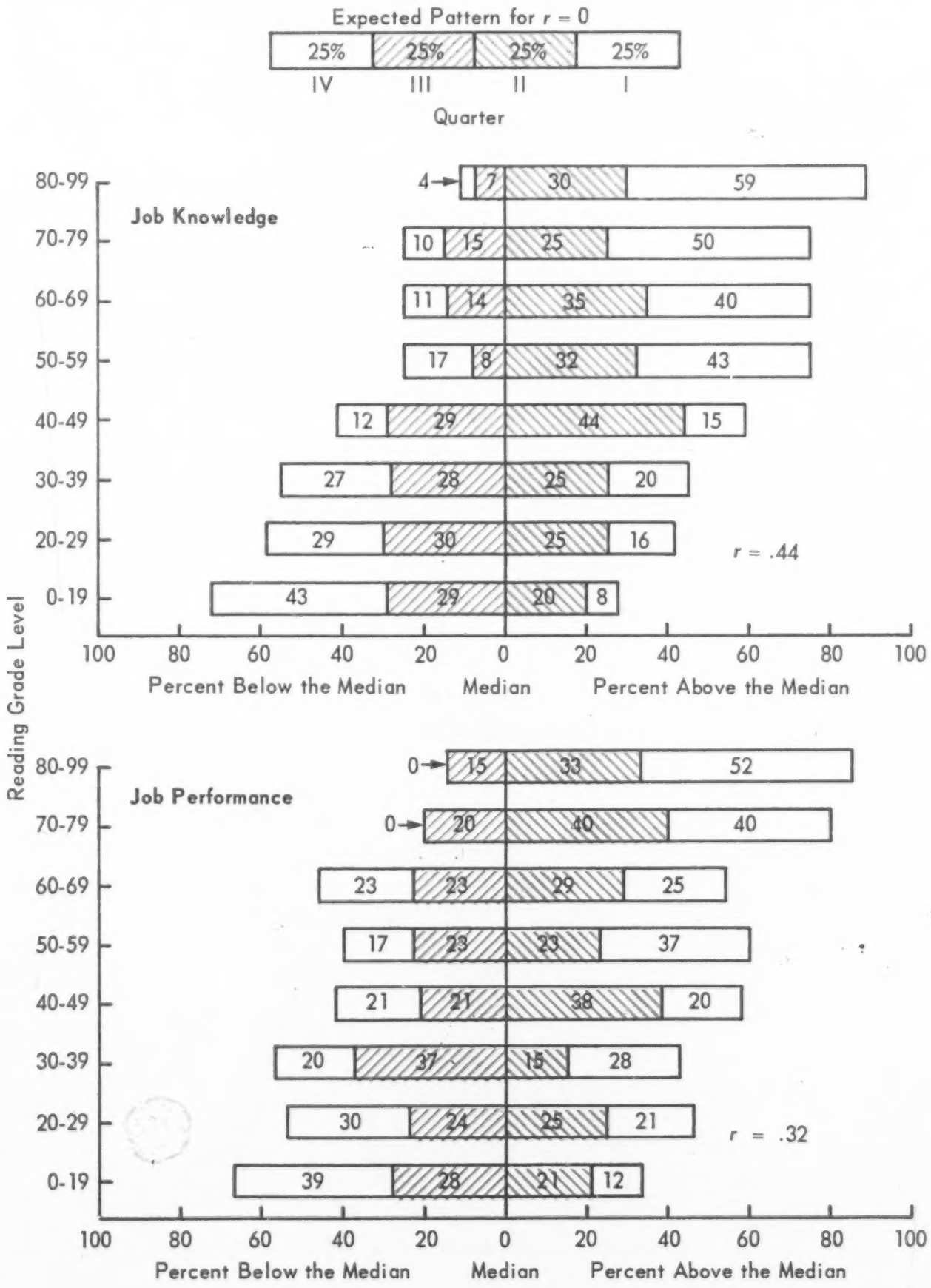


Figure 22

Quarter Distributions of Job Knowledge and Performance by AFQT Level: Cook *(MOS 94B)*

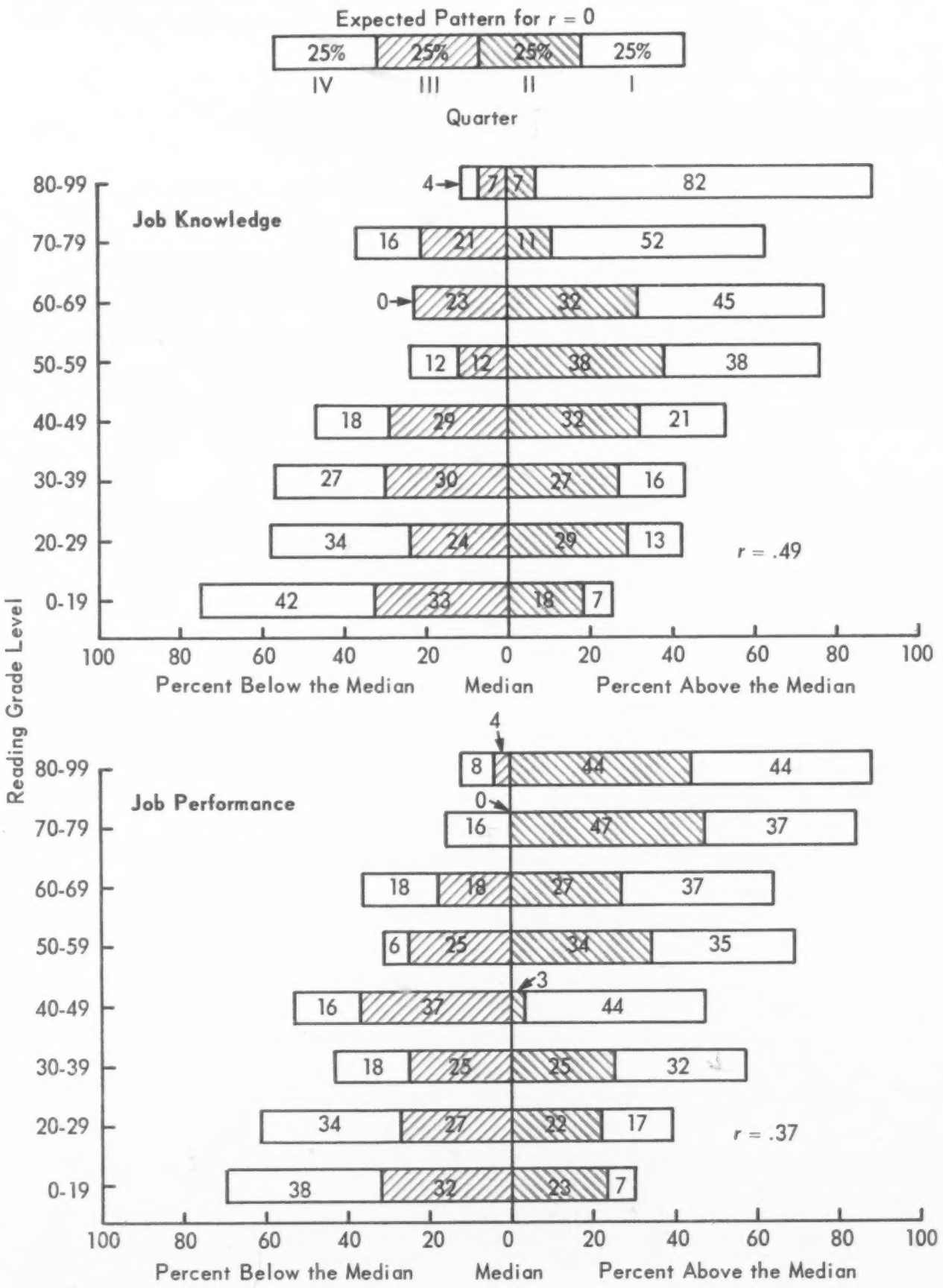


Figure 23

Chapter 5

REDUCING DISCREPANCIES BETWEEN LITERACY LEVELS AND JOB DEMANDS

Research described in Chapter 2 focused on the differences between the reading difficulty levels of the printed materials available for performing a job, and the reading ability levels of the men who are supposed to use these materials. In two of the job areas described, the reading demands of the materials were considerably above the skill levels of the men in those jobs.

In the present chapter we discuss two approaches aimed at closing the gap which results when the literacy demands of a job exceed the literacy skills of the men available to perform the job. One approach is to increase the skill levels of personnel by training, the other is to modify the literacy demands of the job by the redesign of literacy materials. These approaches are fairly obvious and easy to verbalize, but their implementation is neither simple nor inexpensive. Also, they may have entirely different outcomes with respect to a major criterion for the implementation of any such action—the improvement of personnel job proficiency.

LITERACY TRAINING AND JOB PROFICIENCY

With reference to closing the gap between job literacy demands and personnel literacy skills through literacy training, one of the most frequently mentioned programs is the large-scale training of functional illiterates in the armed forces during World War II. Figures reported by Goldberg (8) in his extensive review of Army training of illiterates in World War II indicate that, subsequent to June 1, 1943, 302,838 men received literacy training. Of these, 254,272 were graduated because of attainment of required standards, which were designated as literacy skills as possessed by the completion of the fourth grade of school.

Such successful performance during World War II is frequently cited by reading experts (9,10) as an example of an approach for upgrading the literacy skills of adults to render them better, more competent job performers. However, the evaluation of the effects of literacy training on job proficiency was almost nonexistent, and such evaluation as was attempted was fraught with methodological difficulties.

One attempt at such assessment was made by Hagen and Thorndike (11), who compared the records of 1,026 illiterates who entered the Navy during 1944 and who received literacy training at Camp Peary with the records of 1,021 normal control cases who entered at the same time and from the same parts of the country. The records of 999 marginal aptitude men were also studied to give a comparison with men comparable to illiterates but who did not receive literacy training.

Unfortunately, several methodological limitations restrict the conclusions of this study. For one thing, the control group contained no enlistees. For another, the marginal group was superior to the illiterate group in literacy, general intellectual ability, and education level. The marginal group also differed in age and background, and in many cases records were incomplete and inconsistent. Thus, the illiterates who received training were not comparable to the control group of marginal aptitude men. Relative, however,

to the normal and marginal control groups, the illiterates who received literacy training were subsequently characterized by fewer promotions, lower proficiency ratings, more disciplinary actions, more lost time due to misconduct, fewer honorable discharges, and more VD than the controls. Thus, in this case, literacy training did not result in producing men comparable in job proficiency to marginal aptitude men who did not receive such training, nor to normal aptitude men.

Since World War II, the Armed Services have had additional opportunities to conduct literacy training, and to evaluate the effectiveness of this training in job proficiency. Perhaps the best work is that reported by Goffard (12). In this study, men who scored below the 5.0 grade level of reading on a standardized reading achievement test were given special literacy training. They were graduated from training upon achievement of reading at the 4.9 grade level. When compared with comparable control groups, that is, marginally literate men who did not receive special training, the experimental group did slightly better on performance and knowledge tests given at the end of basic training. Differences were not considered of any practical significance, however, being less than 5% in any case.

Additional studies to evaluate the effects of literacy training on job proficiency in the Armed Services are reviewed in the book *Marginal Man and Military Service*, prepared by the Department of the Army in 1965 (13). The upshot of these studies is that little benefit to job proficiency has been demonstrated from training in basic literacy skills. It is important to point out, however, that none of the literacy training aimed at providing literacy skills in excess of those represented by a score of 5.0 on standardized reading tests. In this regard, the work reported in Chapters 3 and 4 of this report suggests that, if training in reading and arithmetic is to have any notable impact on job proficiency, it should be extended to at least the grade 7.0 level. These data lead also to the suggestion that literacy training should include training in listening as well as in reading. While these skills are intercorrelated to a degree (r=.55), they are apparently not identical. More will be said later about reading and listening.

Apart from the limited data based on military literacy training programs, no additional research evaluating the effects of remedial literacy training on job proficiency has been found. To date, the hypothesis that adult-level remedial reading training will improve job proficiency remains an hypothesis. But it seems clear that, if such training is to have any notable effect on job proficiency, it should be functionally related to a particular job field, and it should extend at least to the 7.0 or 8.0 grade level. This is not to say that persons with less than seventh or eighth grade reading skills cannot perform successfully in a variety of jobs. The data from Chapter 4 clearly indicate that a number of less literate men can perform a variety of job tasks. But for the most part, those jobs can be, and probably were, learned by being told or by imitation. However, as indicated, even in these jobs which are high density for Mental Category IV men, the ability to read at or above the seventh or eighth grade level was associated with improved job proficiency.

MODIFYING JOB-RELATED READING DEMANDS BY SUBSTITUTING LISTENING FOR READING

The literacy training approach to reducing the gap between personnel literacy skills and literacy demands of jobs involves training the men to more closely match their skill levels to the skill level demands of the job. An alternative or adjunct to remedial literacy training is to reduce a "literacy gap" by means of changing the literacy demands of the job. Considerable work has been done in Work Unit REALISTIC to determine the

feasibility of lowering the reading demands of jobs, and job training programs, by substituting listening for reading materials.

The research on listening performed in REALISTIC can be categorized into four groupings: (a) studies of listening as a job skill; (b) reading versus listening as learning processes; (c) characteristics of listening materials related to learning by listening, and (d) research to increase the amount learned by listening in a fixed amount of time. The research findings in each of these categories are summarized below.

Listening as a Job Skill

As indicated in Chapter 2, to better understand the importance of listening for job performance, Repairmen, Cooks, and Supply Specialists were interviewed at their job sites regarding the extent to which they used reading (manuals, charts, etc.) and listening (peers, supervisors) sources to obtain job information. Results indicated that Repairmen and Supply Specialists reading in the grades 4.0-6.9 range tended to rely as much (or more) on listening sources as on reading sources for job information. Those with better reading ability relied less on listening and more on reading sources for job information. It was also found that the Cook job involved much less difficult reading materials than the Repairman or Supply Specialist jobs, and there was a marked increase in the use of reading relative to listening as a source of job information, even for the poorer reading men in the Cook job. Thus, the on-the-job interviews indicated that, where reading materials are difficult, men of poor reading ability rely heavily upon listening as a basic source of job information.

Further indication of the importance of listening as a job skill was obtained by comparing the job proficiency of men of differing listening abilities working as Armor Crewmen, Repairmen, Supply Specialists, and Cooks (Chapter 4). Significant correlations were obtained in all jobs between listening and job knowledge (paper-and-pencil) tests and job sample tests, that is, tests in which men performed actual samples of work: cooks cooked, repairmen repaired vehicles, and so forth. With regard to the work sample tests, listening skill predicted performance as well as reading skill or AFQT did. Furthermore, within a restricted range of AFQT scores (0-30), listening ability predicted job sample performance as well as the full range of AFQT scores did (2). Thus, listening ability appears to be a useful dimension for additional screening of Army inductees, and it would be useful to explore the use of a listening test for screening purposes.

Both the on-the-job interviews and the intercorrelations of listening and job proficiency have underscored the importance of listening as a job literacy skill. Another aspect of concern was a determination of how reading and listening might compare as processes for learning job information.

Reading Versus Listening as Learning Processes

To compare the relative effectiveness of learning by reading or by listening, we prepared the same prose materials as either reading or listening test passages (3). Men of low mental aptitude (AFQT scores 10-30) and of higher mental aptitude (AFQT scores greater than 30, with a mean of 63) were administered the reading and listening test materials, which included materials of grade levels 6.5, 7.5, and 14.5 (Flesch readability scores). With reading time limited to that available for listening, the men in both aptitude groups learned as well by listening as by reading.

To find out who might prefer to learn by listening rather than by reading, a survey of men in several MOSs was conducted (4). The survey indicated that preference for learning by listening increased with decreasing reading ability (and decreasing AFQT). This is consistent with the results of the on-the-job interviews (Chapter 2), which

indicated that Repairmen and Supply Specialists of lower reading ability learned much of their job information by asking and listening to others rather than by reading.

These two studies suggest that many types of prose materials could be effectively prepared as listening materials so that those who preferred to learn by listening might do so.

Characteristics of Listening Materials Related to Learning by Listening

A series of basic research studies was conducted in REALISTIC III to identify various factors which affect the comprehensibility of listening materials (3,4). Two of these studies indicated that, as materials decreased in readability (assessed by means of a readability formula), they are more difficult to comprehend for both high and low aptitude (AFQT) men. Also, low association strength word pairs (e.g., table-river), embedded within sentences were not learned as well as high association strength word pairs (e.g., table-chair) embedded in sentences.

Additional work further indicated the importance of linguistic cues to meaning in learning by listening. In that research it was found that the listening comprehension of high aptitude men increased directly as the listening conditions were varied from no message (baseline), to presentation of the message with the words individually spoken and presented in random order, to presentation of the words individually spoken but sequenced into a meaningful story, and finally to a normal, prose-like version of the message containing inflection, pausation, and rhythmical cues to meaning.

These studies indicate that, for practical purposes, measures of readability can be used as measures of listenability and that materials which are easier to read and comprehend will, on the average, also be easier to listen to and comprehend. Thus, difficulty level of listening materials can be monitored by a readability formula applied to the prose transcript.

The data on association strength of words within sentences, and on the influence of linguistic cues on the comprehension of materials indicate that listening materials should be prepared using most generally known terms, preferably concrete rather than abstract. The materials should be produced with full use of intonational, inflectional, and dramatic cues to meaning.

In conjunction with the above research concerning the structural aspects of the listening message, considerable attention has been given to the rate of presentation of the messages (3,4). In general, this work has indicated that increasing the rate of speech reduces the comprehensibility of the message, although this reduction is usually negligible for speech rates up to around 250 wpm (with variability due to the task demands). Further research has suggested that the effects of varying the speech rate may be different for high mental aptitude and low mental aptitude subjects, depending upon the nature of the listening materials. However, this research is insufficient for suggesting generalization in this regard.

It is safe to say, however, that, for both high and low mental aptitude subjects, increasing the rate of presentation of a message to above 300 wpm will almost certainly have a significant detrimental effect on comprehension. Viewed otherwise, however, these studies indicate that listening materials recorded in the "normal" range of speech rates (e.g., 125-175 wpm) can generally be compressed by as much as 20-30% without a large loss in comprehensibility. Thus some tradeoff is feasible; a (generally) small loss in comprehension can be traded for what may be considerable savings in time.

Research to Increase the Amount Learned by Listening in a Fixed Amount of Time

The fact that listening time may be saved by the time compression of listening materials, while producing only a small loss of comprehension, suggests the possibility of using the time savings to improve the overall learning of the materials. This was attempted in a study in which compressed materials were presented twice in the same amount of time required to present the uncompressed message once (3). While such repetition did restore the comprehension of compressed materials to normal, for both high and low mental aptitude subjects, overall learning was not improved.

An additional study (4) attempted to use the time saved by the compression process to present additional information, with the idea of increasing the total amount learned in a given amount of time. However, neither high nor low mental aptitude subjects learned a greater amount when extended, compressed information was presented, as compared with what they learned when less, uncompressed information was presented. Thus, the limited research to date has not been successful in using the time saved by the time-compression procedure to improve learning over that obtained with non-compressed materials.

However, shortcomings of this work are many, and more information is needed to determine the utility of time saved by the compression of speech. At present, research evidence speaks against using this time to simply repeat the entire message or to add new information. Possibly, peak comprehension might be improved by selectively repeating or elaborating upon the more important aspects of the materials. It might also be useful to insert questions into the material to focus attention on upcoming or recently presented material. In general, however, the importance of the speech sampling, rate variation technique for education and training is the technological feature of being able to expand or compress recorded materials. This makes possible the provision of listening rate options for a variety of students.

Summary on Substituting Listening for Reading

The work done on the feasibility of substituting listening for reading as a means of reducing the literacy demands of jobs has been exploratory and fundamental in regard to rate-controlled recordings. This work indicates that men, all along the continuum of aptitude, can learn certain verbal prose as well by listening as by reading. Work in REALISTIC using rate-controlled recordings suggests that, in some cases, both high and low aptitude men can learn less difficult materials at rates of speech more than four standard deviations above the mean rate of 175 wpm with only moderate losses in comprehension. While this may result in as much as a 36% savings in listening time, it remains to be demonstrated how the time saved might be used to increase the general level of learning. Projected research on HumRRO Work Unit LISTEN (Development of Automated Programs to Improve Listening Skills Required in Army Jobs) includes a further examination of this problem, as well as research to study the effects of speech rate upon particular information processing procedures used by high and low aptitude men. The primary objective of Work Unit LISTEN, however, is to attempt to improve listening skills through special training.

DESIGN OF JOB PERFORMANCE AIDS TO REDUCE LITERACY DEMANDS OF JOB

A job performance aid is any information storage device, such as a manual, checklist, or diagram, which is available to assist a man in doing his job. The present discussion is concerned primarily with technical manuals as job aids, and the focus is on

the design of such manuals so as to render them more effective. There is considerable evidence (14, 15, 16) which indicates that properly designed job manuals can enable the less experienced and less literate man to achieve acceptable job performance, with fewer errors and little or no loss in time, and with much less training than has been thought necessary. This has been demonstrated for highly technical jobs in which complex machines and electronics systems are involved.

The major principle underlying the success of well-designed aids is that job-related information, which is usually stored in a man's head, is stored in the aid *in such a way as to maximize the retrievability of the information.* Thus, the long training or on-the-job experiences which are usually needed for a man to acquire the needed job information are reduced to the time needed to learn to use the job aids.

It must be emphasized, however, that it is not the mere storage of information in the aid rather than in the man's head which accounts for the effectiveness of the aid. Rather, it is the nature and manner of storage that is of crucial importance. For instance, a technical manual may contain needed information, but this information may be stored in such a way that the user is not able to work with it. In this regard, the research reported in Chapter 2 is relevant. That research indicated that while the technical manuals in the Repairman and Supply Specialist jobs do present job-relevant information, they are written at a level well above the reading ability of the men within the job, and hence there is a low level of usage of the materials. In addition to the reading difficulty level, other factors such as format, and nature and sequencing of information, may reduce the effectiveness of a job manual.

The key, then, to the success or failure of the job manual or other aid is its design, which includes the nature and manner of presentation of the information in the aid. The foundation for the effective design of such materials is stimulus-response learning theory as applied to jobs by human factors scientists. In applying stimulus-response theory to job aid design, the job is viewed as being composed of a set of tasks in which the worker makes some appropriate responses to a stimulus which cues that response. By performing a task analysis, the various cueing stimuli and their associated responses are identified. Decisions can then focus on determining which cueing stimuli are to be placed in the job aid, and how they will be displayed. Further details of the process of developing job performance aids are available in another report (17).

The overall results of the review of job performance aids in REALISTIC suggests that the provision of more usable job materials may be the most rapid, least expensive method of assuring that job proficiency is attained by men across a wide spectrum of literacy or verbal aptitude skill levels. There is even some evidence (Chapter 2) to suggest that the use of printed materials may be facilitated more by the design characteristics of the materials than by increasing the reading skills of men, and this may be true for able as well as for poor readers.

The fact that it is possible to design materials to permit marginally literate men to perform jobs satisfactorily indicates that it is feasible to hire the less literate man and to utilize him effectively, while providing literacy training to upgrade these skills. By this means it should be possible to employ the marginally literate in responsible, growth-oriented jobs, while maintaining the efficiency and effectiveness of the job subsystem.

Chapter 6

SUMMARY AND MAJOR FINDINGS

Work Unit REALISTIC was conducted to (a) provide information concerning the demands for reading, listening, and arithmetic skills in several major military occupational specialties, and (b) to provide information and suggestions for reducing discrepancies between personnel literacy skill levels and the literacy skill levels required by the job. The four MOSs studied—Armor Crewman, General Vehicle Mechanic, Unit and Organizational Supply Specialist, and Cook—have relatively high input of lower aptitude men, and hence literacy skills are of concern.

In this report, data are presented which indicate relationships between reading, listening, and arithmetic skills of men in the cited MOSs and their job proficiency as measured by tests of proficiency on (a) job-related reading tasks, (b) job knowledge (paper-and-pencil) tests, (c) job performance (work sample) tests, and (d) supervisor ratings. In addition, data are presented concerning the reading difficulty level of printed materials in the Cook, Repairman, and Supply Specialist MOSs, and the extent of usage of these materials by men of different reading ability levels. Data are presented to indicate the extent to which men of differing reading levels ask questions of and listen to others (peers, supervisors) for job information. The extent and nature of use of arithmetic by men of differing reading ability levels is also discussed. The major findings on several categories of information are summarized below.

(1) **Information concerning the reading difficulty levels of materials in each MOS**

Reading materials for Repairmen and Supply Specialist exceeded the average reading ability levels of non-Category IV men by some four to six grade levels, and the reading levels of Category IV men by six to eight grade levels. The reading materials used by Cooks consisted of recipes primarily, and were written at a grade level comparable to the reading ability of men in both mental categories.

Literature research indicated that much of the printed materials in the jobs studied could be redesigned to make them easier to use and comprehend.

(2) **Information concerning the use of reading materials by men of different reading abilities in each MOS**

For Repairmen and Supply Specialists, it was found that the use of printed materials increased with increased skill in reading. Also, job sample test performance was better for Repairmen and Supply Specialists who used manuals. In the Cook job, skill in reading was unrelated to use of reading materials. This appeared to be related to the simple format and syntax of the Cook's references which were cited by job incumbents.

There was some evidence to suggest that the easier the printed material, the more it was likely to be used. Hence, increasing the use of reading materials might be accomplished both by redesign of materials and by remedial training in literacy.

(3) **Information concerning the use of listening sources on the job as a function of reading ability**

Supply Specialists and Repairmen who read at the 4-6.9 reading grade levels tended to rely as much (or perhaps a little more) on asking others for information as on reading for information, to a greater degree than men of higher reading levels. This was not true in the Cook job where the reading materials were easiest.

Non-Category IV and Category IV men were found to learn prose materials of a wide range of difficulty levels as well by listening as by reading. Also, a significant

(49%) of a sample of men reading at the 4-6.9 grade level indicated they would prefer to learn by listening rather than reading.

These findings underscore the importance of non-reading language skills in job performance. Listening as a communication skill is being further studied in a follow-up to REALISTIC in HumRRO Work Unit LISTEN.

(4) **Information concerning the use of arithmetic on the job as a function of reading ability**

Interviews with job incumbents in the Repairman, Supply Specialist, and Cook jobs indicated very little use of arithmetic. Where used in the Repairman and Supply Specialist jobs, however, this use was greater for higher reading ability men. This was not true for cooks.

Lower reading level (4-6.9) men in the Repairman or Supply Specialist jobs tended to use mostly whole numbers or gauges in their arithmetic, while higher reading ability men used more complex arithmetic (fractions, decimals). In general, it seems as though men with better reading skills perform different, more responsible job duties, in which precision and accountability are demanded, than men with lower reading skills. Hence, they use more complicated arithmetic. However, no demand for skills beyond what is ordinarily taught at the sixth grade in school was found.

(5) **Information concerning reading ability and proficiency on job related reading task tests**

Performance of new accessions on job-related reading task tests for Repairman, Supply Specialist, and Cook MOSs correlated approximately .76 with performance on the standardized, grade school referenced reading test. This correlation was .65 for job reading task test and AFQT. Thus, the standardized reading test was a better predictor of proficiency on job-related materials than the AFQT was.

(6) **Information concerning reading, listening, and arithmetic skills and proficiency on Job Knowledge and Job Sample performance tests, and supervisor ratings**

Only inconsequential relationships of any of the literacy variables to supervisor ratings were found for any MOS. The reading test score and AFQT appeared to measure the same thing to a large degree. Both predicted job proficiency equally well in all four MOSs. Thus, if the purpose of a cognitive test is simply to predict future job proficiency as measured by job knowledge or job sample scores, the AFQT is adequate.

However, the Standardized Reading Test (SRT) predicted job knowledge and job sample performance about as well as the AFQT did and, in addition, the SRT predicted performance on the job reading tasks. The SRT thus out-performs the AFQT by predicting proficiency in a skill used in the job—job-related reading. It also indicates whether a person exceeds some minimal cut-off point, and how far a man is below or above some targeted reading level for different MOSs.

Further, since the reading test provides information about skills which are directly amenable to improvement through training in a recognized content area (i.e., reading), while the AFQT does not lend itself to improvement through training in any recognized content area (i.e., there is no curriculum for teaching AFQT), consideration should be given to research to develop a reading test for screening at the Armed Forces Examining and Entrance Stations. Such research should include an identification of the constraints upon military literacy training programs, and the identification of men of low literacy/language skills who would not be likely to succeed in the remedial programs operating under such constraints.

Relationships of reading to job proficiency suggested a targeted reading level for Cooks of 7.0 grade level; for Repairmen and Armor Crewmen, 8.0 grade level; and for Supply Specialists, 9.0 grade level. These figures are based on the job printed materials and job training procedures existing at the time of the study. If job materials and training procedures were considerably altered, the job proficiency of men reading below the

stated levels could be improved. However, if career advancement is desired, so that a man is expected to assume a supervisor's role, then remedial literacy training—at least to the levels indicated—would be desirable to render general Army and Department of Defense publications useful to the man.

Consistent with this view, it should be stated that, if men of lower literacy skills are accepted into service, then their later job security should not be contingent upon the acquisition of higher skill levels unless formal programs for acquiring such skills are available and emphasized during the early career period. This would seem to be of even greater importance if the manpower requirements are to be filled on the basis of a zero dependency on the draft.

Arithmetic skill is highly related to reading and AFQT and predicts job knowledge and job performance about as well as these other indices. For selection or remedial training criterion purposes, a fifth or sixth grade level would seem sufficient.

Listening and job knowledge were less highly related than reading and AFQT and job knowledge. However, listening was as highly related to job sample performance as were the reading test and AFQT. These findings affirm the importance of listening as a job-related communication skill.

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AND
APPENDICES

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Appendix A

ANALYSIS OF VARIANCE TESTING—LISTENING VS. READERSHIP AS A FUNCTION OF READING ABILITY OF SUPPLY SPECIALISTS AND REPAIRMEN

Source	*df*	Mean Square	*F*	*p*
Supply Specialist				
Between Subjects				
Reading Level (A)	2	2.385	1.22	
Error (Subjects Within Groups)	57	1.956		
Within Subjects				
Listen vs. Read (B)	1	7.94	14.18	<.005
A X B	2	5.56	9.93 [a]	<.005
Error (B X Ss Within Groups)	57	.56		
Repairman				
Between Subjects				
Reading Level (A)	2	1.945	.83	
Error (Subjects Within Groups)	82	2.352		
Within Subjects				
Listen vs. Read (B)	1	21.14	12.81	<.005
A X B	2	10.57	6.41[a]	<.005
Error (B X Ss Within Groups)	82	1.65		

[a]Tests of simple effects of readership and reading level for Supply Specialist significant at $p<.10$ level; for Repairman, $p<.025$. Simple effects of listening by reading ability not significant in either MOS.

Appendix B

STATISTICAL ADJUSTMENT OF PROFICIENCY MEASURES TO REMOVE EFFECTS OF JOB EXPERIENCE

These data present the problem of extremely wide range of job experience in our subjects and substantial relationships between experience and job proficiency. The samples contain men with from one month to more than 20 years of job experience. Average experience is 28 months while the median is only 13 months. In order to remove the linear effects of experience from the proficiency measures, as well as to reduce the problems of curvilinearity of regression and heteroscedasticity, all job proficiency measures were adjusted to remove the effects of experience. This consisted of:

(1) Performing a logarithmic transformation on the experience (months on job) measures.

(2) Calculating the linear regression of each proficiency measure on the log experience variable.

(3) Determining the regression-based proficiency score predicted for each level of job experience.

(4) Subtracting the estimated proficiency score due to experience from the individual's raw proficiency score.

The adjusted proficiency scores then are residual or deviation scores of individuals above or below that proficiency score attributable to work experience alone and thus have been freed of the linear effects of job experience.

As shown in Table B-1, experience is substantially related to raw scores on both the job knowledge and the performance proficiency measures, and slightly to supervisor ratings. The statistical adjustment reduced all correlations between experience and proficiency to 0.00. Table B-2 contains the correlations between raw and adjusted proficiency measures.

By establishing, through subject selection, an equal number of high and low AFQT subjects at each level of experience, the UTILITY design foreordained the absence of any relationship between AFQT and experience in these data and thereby precluded the question of whether such a relationship does exist in this Army population. To the degree that literacy variables are related to AFQT, as shown in Table 9, the question of whether there is any relationship between literacy skills and overall job success as measured by retention and advancement must similarly remain moot to these data. Table B-3 displays the correlations between both the literacy variables and AFQT and experience as obtained within the design limitations of this study.

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Table B-1

Correlations of Unadjusted Proficiency Measures With Log Months on Job

MOS	Proficiency Measure		
	Knowledge	Performance	Supervisor Rating
Armor Crewman	.55	.69	.26
Repairman	.46	.42	.15
Supply Specialist	.64	.44	.14
Cook	.44	.37	.25

Table B-2

Correlations Between Unadjusted and Adjusted Job Proficiency Measures

MOS	Proficiency Measure		
	Knowledge	Performance	Supervisor Rating
Armor Crewman	.83	.72	.97
Repairman	.90	.91	.99
Supply Specialist	.77	.90	.99
Cook	.90	.93	.97

Table B-3

Correlations Between Literacy Variables, AFQT, and Experience (Log Months on Job)

MOS	Reading	Listening	Arithmetic	AFQT
Armor Crewman	–.07	–.04	–.16	.00
Repairman	.01	.14	–.08	.02
Supply Specialist	.03	.00	–.04	.01
Cook	–.04	.07	–.07	.02

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